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KARYOKINESIS AND CYTOKINESIS

IN THE

Maturation, Fertilization and Cleavage

OF

CREPIDULA and other GASTEROPODA.

BY

EDWIN G. CONKLIN, PH.D.

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CONTENTS.

KARYOKINESIS AND CYTOKINESIS IN THE MATURATION, FERTILIZATION AND CLEAVAGE OF CREPIDULA AND OTHER GASTEROPODA.[1]

By Edwin G. Conklin, Ph.D.

I.

Introduction.

Cell division, in a broad sense, includes not only nuclear division and the separation of daughter cells, but also all the phenomena which lead up to these processes and which follow them; the terms *Karyokinesis* (Schleicher '78) and *Cytokinesis* (Whitman '87) are used in this paper to include these nuclear and cytoplasmic activities of the entire cell-cycle from one division to the next. Flemming ('82) has objected to the term *Karyokinesis* on the ground, among others, that nuclear movements are not characteristic of indirect division. But in view of the extensive movements of both nuclei and cytoplasm, which occur in the cell divisions described in this paper, the terms *Karyokinesis* and *Cytokinesis* have peculiar appropriateness.[2]

The phenomena of cell division still include an extraordinary number of dark problems, in spite of the fact that "all the search-lights of the biological sciences have been turned upon the cell." Confusion and contradiction exist as to the nature and metamorphoses of the centrosome and central spindle, the origin and fate of the amphiaster, the characteristics and history of the attraction sphere, the existence or non-existence of a specific substance (Archoplasm, Kinoplasm, etc.) whose primary function is the division of the cell. Still less complete is our knowledge of the inter-relation of nucleus and cytoplasm during the various phases of division, of the phenomena and significance of the movements of cells and cell constituents and of the chemical, physical and physiological principles involved in the division of nucleus and cell body.

In the early development of the egg, cell divisions have a peculiar interest because of their bearings on problems of heredity and differentiation. Here are found phenomena of the most general occurrence and of the deepest significance, viz.: the maturation, fertilization and cleavage of the egg and the early differentiation of the embyro. The bearings of the phenomena of maturation and fertilization upon

[1] From the Zoological Laboratory of the University of Pennsylvania.

[2] On the other hand Flemming's term *mitosis* commends itself because of its brevity, and it is frequently employed throughout this paper.

problems of heredity and differentiation are matters of common knowledge and need not be discussed here; the relation of cleavage to these larger problems is neither so generally recognized nor so freely admitted.

In the cleavage of the egg, differentiations occur to a remarkable degree in certain cell divisions, while they appear to be absent in others. Typically, cell divisions are rythmical, alternating, qualitatively and quantitatively equal, and consequently non-differential. The differentiations of cleavage cells are due to departures from this typical condition in one or more particulars. In certain animals these departures are very notable, the cleavage being from the first differential. The differentiations of cleavage may have a far-reaching prospective significance, since in certain animals (annelids, mollusks, polyclades and nematodes) the principal axes and body regions of the future animal are marked out by the cleavage planes and entire organs are represented by a single cell or group of cells. In such cases the minutest details of unequal, bilateral or qualitatively dissimilar division of cells may be of great importance. The forms and peculiarities of such cleavage are inherited quite as certainly as are any adult features, and when the problem of inheritance may be reduced to a certain peculiarity of a certain cell division it is evident that we have this problem reduced to relatively simple terms.

The species which has formed the chief subject of this work and from which all the figures are drawn is *Crepidula plana* Say. The following species and genera have also been studied more or less completely:—

C. fornicata Lam., *C. convexa* Say, *C. adunca* Keep, *Urosalpinx cinerea* Stimpson, *Sycotypus canaliculatus* Gill, *Fulgur carica* Conrad, *Haminea solitaria* Say, *Æolis papillosa* Loven.

Many of the phenomena here recorded, particularly those relating to protoplasmic movement and the history of the centrosomes during cleavage, have been observed in all of these seven species of Prosobranchs and two species of Opisthobranchs. These phenomena are, therefore, not isolated, and it is probable that they are of wide occurrence.

Methods.

The eggs of *Crepidula* are in many respects peculiarly favorable for study. These mollusks are very abundant and the eggs are deposited in large numbers, a single female usually laying from eight to ten thousand eggs. No other egg with which I am acquainted is so favorable for the study of cleavage. The eggs are inclosed in membranous capsules, which reagents readily penetrate; however, in order to insure rapid fixation I have usually punctured the capsules with a needle before putting them into the fixing fluid; they are then passed through the various reagents and finally imbedded and sectioned while still in the capsules. Each female of *C. plana* deposits an average of fifty capsules, with approximately 175 eggs in each capsule. The eggs vary scarcely at all in size, each being about 0.136 mm. in diameter. The great advantage of being able, without further trouble, to handle in large numbers such small eggs will be at once apparent. On the other hand the eggs are unfavorable in having a relatively large quantity of yolk which is colored deeply by most stains.

Two general methods of observation have been followed: (1) the study of entire eggs; (2) the study of serial sections. For the former the best method of preparation is as follows: The living eggs are teased from the capsules into Kleinenberg's picro-sulphuric fluid, or into Boveri's picro-acetic, where they are left from thirty minutes to two hours; they are then washed in alcohol until the eggs become nearly white, and are stained in the following solution for from five to ten minutes.

Delafield's hæmatoxylin	10 cc.
Distilled water	40 cc.
Kleinenberg's picro-sulphuric fluid	10 drops.

Eggs so stained are washed in alcohol, dehydrated and mounted in balsam. If the eggs of *C. plana* are mounted under a thin cover, supported at one side by a bit of glass .15 mm. thick (the eggs are about .136 mm. in diameter), they can be studied under an immersion lens and the relative positions of nuclei, centrosomes, spheres and mid-bodies ("Zwischenkörpern"), can be determined as would be impossible in sections.

I have tried many modifications of this stain, but have found none so good as the one given. The yolk is left transparent yellow, while the protoplasm is of a rosy tint, and the chromatin, centrosomes and mid-bodies are blue or black. I have found by experience with the eggs of many mollusks, annelids, crustacea and insects, that this method is especially useful with eggs in which there is much yolk.

Eggs fixed in Kleinenberg's fluid are always more transparent than those fixed in Boveri's, the yolk stains less and the spheres, centrosomes, spindles and mid bodies stand out more clearly. On the other hand the structure of the cytoplasm is not so well preserved in Kleinenberg's as in Boveri's fluid.

For sectioning the following fixing fluids have given good results: Flemming's, Hermann's, Boveri's picro acetic, Graf's picro-formol; while the following were less satisfactory: Kleinenberg's fluid, Perenyi's fluid, chromo-acetic, chromo-formic, sublimate-acetic, sublimate (sat. sol.). Many different stains were used, among them Heidenhain's iron-alum and Delafield's hæmatoxylin, either alone or in combination with orange G., Bordeau red, eosin or acid fuchsin; Hermann's saffranin-gentian-iodine; Biondi-Heidenhain's mixture; Auerbach's acid fuchsin and methyl green, etc. The best results were obtained with material fixed in Boveri's picro-acetic and stained in Delafield's hæmatoxylin and orange G.[1]

Many preparations which were so stained were afterwards decolorized and restained with iron hæmatoxylin and Bordeau red. In this way it was possible to observe certain details of structure which could not otherwise be determined with certainty. Since there are always devotees of certain fixing and staining media who refuse to accept results unless their favorite methods have been employed, I may say here that every important result of my work has been confirmed by material fixed and stained in each and every one of the methods enumerated above. These results, therefore, cannot be attributed to the exclusive use of one or two media.

In general the eggs were imbedded in paraffine in the usual way, but owing to the fact that they contain a large quantity of yolk and are, therefore, more or less friable, some were doubly imbedded in celloidin and paraffine, after the method suggested by Kultschitzky ('87) and by Ryder ('88). This method is especially valuable for tracing the movements of the pronuclei and spheres through the yolk. The advantages of this method over ordinary celloidin imbedding are that thinner sections can be had, and that these can be cut in series or ribbons. Its most serious disadvantage is that the sections are usually much folded and cannot easily be flattened.

MATURATION.

A. Pre-division Stages.

1. The Ovarian Egg.—In the stages just before its escape from the ovary, the egg of *C. plana* is irregular or polygonal in outline, being pressed into this shape by surrounding eggs, and it contains a very large germinal vesicle located near the center of the cell. The egg is filled with yolk spherules, which vary greatly in size; there is extremely little cytoplasm visible, and this lies close around the nucleus. The latter contains a single large nucleolus, within which is a

[1] The great value of Heidenhain's iron hæmatoxylin method I have had abundant occason to verify. I have used it extensively in this work and for certain purposes it is without an equal; but having said this, I wish to add that it is not by any means the best stain for all purposes and with all material, as some recent workers seem to suppose. It is not, as is now well known, a specific centrosome stain. In all molluscan eggs which I have examined the yolk stains as densely and retains the stain almost as tenaceously as the centrosomes. For this reason I have found it impossible by this method to recognize small centrosomes and asters in a dense mass of yolk, whereas with the picro-hæmatoxylin the yolk is left a clear yellow, while the aster is red and the centrosome black. The iron hæmatoxlin is also a less delicate stain for spheres and cytoplasm than picro-hæmatoxylin while, of course, it cannot be used at all in the preparation of entire eggs.

more densely staining body, usually eccentric in position, Plate I, fig. 1. The chromatin is in the form of small granules, varying in size and irregular in shape, which are attached to linin threads stretching through the vesicle. Many of these granules can be seen to be three- or four-parted, though others are rounded or irregular in shape. The four-parted granules are larger than the others but all are extremely small; their method of formation was not observed. At this stage no trace of centrosomes can be found anywhere in the egg.

2. Egg Laying.—After the eggs leave the ovary they descend to the lower enlarged part of the oviduct, where they meet spermatozoa from the *receptaculum seminis* and together with an albuminous fluid are surrounded by a glairy, mucous substance, which hardens into capsules. These capsules are attached together in a cluster and are fastened by a common stalk to the object upon which the female is seated. All the eggs laid by one individual begin development at nearly the same time and proceed with remarkable uniformity, so that whenever examined they are all found to be in approximately the same stage.

The earliest stages of free eggs which I have seen were taken from the oviduct while the capsule was being formed. The outline of the egg at such a stage is usually elliptical or irregular, being in marked contrast with the spherical form which it attains after the entrance of the spermatozoon. The germinal vesicle is slightly eccentric in position and immediately around it there is a small amount of cytoplasm in the interstices between the yolk spheres; elsewhere in the egg the yolk spheres are closely crowded together. The nucleolus is now a single, homogeneous body and frequently exhibits an alveolar or recticular structure. The chromatin granules are rounder and a little larger than in the ovarian egg and many of them are arranged in rows or strands, fig. 2. In one egg of this stage I observed two minute granules in the cytoplasm, close to each other and in contact with the nuclear membrane; these are possibly the centrosomes, though no polar radiations or central spindle was observed. At this stage the spermatozoon has not entered the egg (Plate I, fig. 2).

B. Maturation Divisions.

1. Nucleus.—The earliest trace of the first maturation division which I have seen appears about the time of the entrance of the spermatozoon. The centrosomes are now plainly visible, being surrounded by a few short radiations, and are connected by a central spindle. At the same time the nuclear membrane is indented opposite the poles of this spindle and fibres can he traced from the centrosomes to these indented areas, Plate I, figs. 3 and 4.

At this stage the germinal vesicle contains a great number of chromatin granules which are connected together by linin threads, also a single extremely large nucleolus, while the nuclear sap fills all the interstices within the nucleus and constitutes the greater part of its bulk.

(a). *Chromatin.*—A few of the chromatin granules are larger than the others and their form is spherical, 2-lobed, 3-lobed or 4-lobed. They are probably identical with similar granules found in the pre-division stages. They differ much in

size and for this reason their number cannot readily be determined since they grade down to the smaller granules, which are innumerable (Plate I, figs. 3 and 4). These larger granules continually increase in size and become the chromosomes of the first maturation spindle; some of these granules stain less deeply at the center than at the periphery. As the chromosomes grow in size the remaining chromatin granules, which constitute the chief bulk of chromatin within the germinal vesicle, grow smaller and smaller and are gradually dissolved; on the disappearance of the nuclear membrane they escape with the nuclear sap into the cytoplasm, figs. 5, 6 and 7. At the same time the linin threads, which were plainly visible at an earlier stage, fig. 4, are no longer to be seen, but the arrangement of some of the granules in radiating lines, fig. 5, is probably to be taken as evidence that some of these threads still exist. In the early stages of the first maturation division, all the chromatin granules stain alike, in later stages the chromosomes stain more densely with nuclear stains, while the remaining granules show an increasing affinity for plasma stains. In such stages as are shown in figs. 3 and 4, there are no perceptible differences, save size only, between the granules which become chromosomes and those which dissolve; the fact, however, that the history of these two groups is so different shows there is some fundamental difference between them. It is highly probable that the faintly staining granules which are ultimately dissolved or transformed into linin are identical with the lanthanin or oxychromatin of Heidenhain ('94).[1]

(b). *Nuclear Sap.* Before the solution of the oxychromatin granules and nucleolus begins, the nuclear sap is a clear and almost non-colorable fluid. As the solution of these elements progresses the nuclear sap becomes granular and tingible, staining blue or purple with Delafield's hæmatoxylin alone, though it stains deeply with plasma stains, such as eosin or orange G. when these are used after the hæmatoxylin. Even after the nuclear membrane has entirely disappeared the nuclear sap and oxychromatin can still be recognized as a granular mass, figs. 5, 6, 7.

Korschelt ('95) has observed a similar increase in the staining properties of the nuclear sap of *Ophryotrocha*, where the "Kernsaft" stains more and more deeply as division advances until it becomes so dark that the chromatin threads are invisible. Then the sap loses some of its staining qualities and, at the same time, disdissolved nucleolar substance is probably added to the chromatin threads.

[1] The term *Achromatin*, as used and defined by Flemming ('82, p. 375), is limited to "that formed substratum of nuclear structures, as well as of the division figures, which is not colored by nuclear stains." As thus defined, it is applicable only to the linin, and is not even applicable to it at all stages in the cell cycle, since the linin also is colored by nuclear stains at certain stages. Furthermore, it is extremely probable that oxychromatin is transformed into linin at certain stages, and that oxychromatin and perhaps linin are sometimes dissolved in the nuclear sap. This interrelation of these various parts of the nuclear substance makes it impossible to apply the terms "chromatin" and "achromatin" as used by Flemming. Nevertheless, it is convenient to have a term which will include all of the nuclear constituents which do not form chromosomes, as contrasted with that which does. Since the term achromatin has frequently been used in this sense, and since I am unwilling to further cumber cytological nomenclature with new names, I shall employ the term "achromatin," or "achromatic substance of the nucleus" to include all the contents of the nucleus except the chromatin, and even that portion of the chromatin which does not form chromosomes. As thus used it includes linin, oxychromatin, nuclear membrane and nuclear sap.

(c). *Nucleolus*—The chromosomes, which are at first widely scattered through the nucleus, figs. 3 and 4, gather together more closely and often lie immediately around and upon the nucleolus, figs. 5 and 6. In some cases it looks as if these chromosomes were being formed out of the substance of the nucleolus, and the fact that the nucleolus diminishes in size as the chromosomes increase lends color to this view. On the other hand, when the chromosomes first appear they are scattered through the entire nucleus and do not lie close to the nucleolus, and though it is possible that they may later receive substance from the dissolving nucleolus, it is impossible to suppose that they are fragments of the nucleolus. The latter is gradually dissolved without any fragmentation. Before the complete disappearance of the nuclear membrane the nucleolus has greatly diminished in size, and at the same time the nuclear sap stains more deeply, fig. 5. After the disappearance of the nuclear membrane the nucleolus comes to lie outside the spindle, while most of the chromosomes are found within it, though some of them may still be scattered among the polar radiations, fig. 7.

Within the cytoplasm the nucleolus continues to diminish rapidly in size and soon entirely disappears, figs. 8, 9, 12*a*. In this respect the history of the nucleolus in the first maturation of *Crepidula* is the same as has been described by Häcker ('93), Foot ('94), Mead ('95), Wheeler ('95), Obst ('99), and others, in a considerable number of animals.

(d). *Chromosomes.*—The shapes of the chromosomes of the first maturation spindle are shown in figs. 7–15 and in text fig. I. In the early prophase the most common form is that of a 3- or 4-lobed body; in fact, such bodies are found in the nucleus of the ovarian egg. There can be little doubt that these are the "tetrads" of authors, though in *Crepidula* they are not always 4-lobed. As these chromosomes increase in size a hole appears through the middle, between the lobes. There are also found circular or elliptical rings which may be completely closed or may be open on one side; also dumb-bell and cross-shaped bodies. All these forms are represented in text fig. I; all the 2-part chromosomes are shown in the first line (A), the 3-part ones in the second line (B), and the 4-part one in the third (C). These forms are grouped according to evident resemblances merely and it is not certain that they always stand in the genetic relations indicated. For example, A, 4 and 5 may give rise to B, 6 and 7; B, 4 and 5 may be only variations of C, 3 and 4, etc. In all cases, however, the short chromosomes of the early prophase give rise to rod-shaped or elongated chromosomes in the metaphase. In some cases (e. g. line A) this is probably accomplished by these chromosomes becoming ring-shaped and by the opening of these rings on one side. If the ring shows no thickenings (A, 2 and 3) a rod-shaped chromosome is formed by its opening, which later becomes dumb-bell shaped (A, 4 and 5); if it shows three thickenings (B, 1–4) it gives rise when opened to a rod with a thickening at each end and one in the middle (B, 5). The 4-part chromosomes (C, 1) are frequently drawn out into cross-shaped ones; these crosses usually have a hole through the middle and each arm of the cross is split lengthwise from this hole nearly to the tips (C, 2 and 3). In later stages the

arms which lie in the spindle axes lengthen, while the transverse arms shorten, the hole disappearing; in this way chromosomes are formed with three enlargements (C, 4 and 5) similar in all respects to those described above (B, 4 and 5). The resemblance of these two forms is so close that it is difficult to explain the differences in their mode of origin. It is possible that forms, such as those shown in B, 4 and 5, are really crosses with short transverse arms, the tips of all four arms being bent toward each other until they nearly or quite meet.

The striking differences in the shapes of the chromosomes of the prophase is continued into the metaphase where at least three distinct types may be recognized as shown in text fig. I, lines A, B and C. In the late anaphase, however, all come back to a cubical or tetrafoil condition; a hole is usually present through the middle of these as in the prophase.

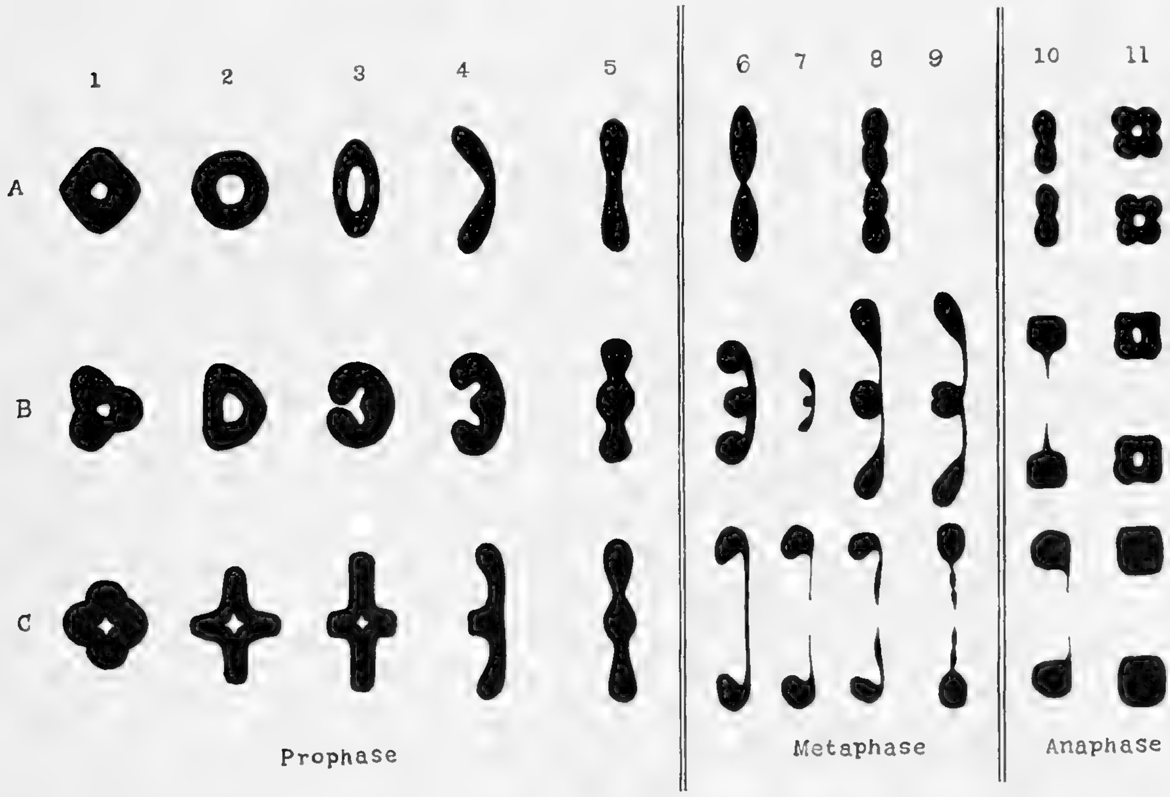

FIG. I.—Chromosomes of the First Maturation Division of Crepidula.

Various authors have called attention to the variety in the form of the chromosomes of the first maturation division (v. Klinckowström '96, Van der Stricht. '98, Foot '98, Lillie '98, Griffin '99). Foot and Lillie figure 3-part chromosomes in the metaphase of the first maturation of *Allolobophora* and *Unio* entirely similar to those in *Crepidula*, and Lillie shows these chromosomes split longitudinally, as they must be, if formed from crosses as shown in text fig. I, line C.

It is difficult to say whether these differences in the shapes of chromosomes mean much or not. On the one hand it is possible that all the chromosomes of a

given mitosis cannot be reduced to a single type; that their differences in shape indicate differences in material substance, and that different chromosomes may therefore represent different heritable qualities. On the other hand these differences in the shapes of chromosomes are generally limited to the first maturation division; they are rarely found in the second maturation and only to a limited extent in the cleavage. Furthermore, there are many evidences that the shapes of chromosomes are conditioned by their linin sheaths, and that the chromatic substance which fills the sheath is of a semi-fluid of viscid character. Thus in the metakinesis of the first maturation, it is always found that the chromosomes have enlarged ends toward the poles of the spindle, and that they are drawn out into thin connecting threads in the equator. In this region the chromosomes are frequently moniliform in shape (text fig. I, C, 8 and 9 and Plate I, fig. 13), and cross sections through the equatorial region of these elongated chromosomes shows many of the latter surrounded by a clear zone, which is bounded by a dark line (Plate I, fig. 12*a*). This clear zone is entirely lacking in sections through the enlarged ends of the chromosomes. In fig. 12*a* one chromosome lies entirely outside of the spindle substance, and yet it is surrounded by this clear zone; this zone and its outer dark boundary is not therefore a mere expression of the absence of spindle substance around the chromosome, but is a structural peculiarity of the chromosome itself, and probably represents a linin sheath, which is separated from the contained chromatin in the equator, but is entirely filled by the chromatin at the poles. After the complete division of this thread of chromatin and its withdrawal into the enlarged ends of the daughter chromosomes, the linin sheath may still be seen for a long time connecting the latter together, and constituting a connective fibre.

The chromosomes grow continually during the early stages of the first maturation division and reach their greatest size in the metaphase when each is from two to twenty times the size of the largest granule present in the germinal vesicle (cf. figs. 3 and 12). After this stage they do not appear to increase in volume. The great differences in the size of chromosomes in the same spindle is almost as striking as their differences in shape; for example, the volume of the largest 3-part chromosome in Plate I, fig. 12 and text fig. I, B, 7 and 8, is about fifteen times that of the smallest; I am unable to say, however, whether this difference in the size of chromosomes is the same in all eggs or not. I do not remember that any one has recorded such enormous differences in the size of chromosomes as are here described. Montgomery ('98) says that the chromosomes of one of the spermatocytic divisions in *Pentatoma* vary greatly in volume, the largest sometimes having six times or more the volume of the smallest. In no other mitosis in *Crepidula* is there such variety in the size of chromosomes, and nowhere else are there such differences in shape.

The number of chromosomes in the first maturation division is thirty, as I have determined by a careful study of the entire mitotic figure, as well as by cross sections through the equatorial plate. Such a cross section is represented in Plate I, fig. 12*a*, and the whole number of chromosomes is there shown. This is undoubtedly the

reduced number of chromosomes; I have been unable to count with accuracy the number present after fertilization, but it is evidently about sixty.

In the early anaphase of the first maturation, the daughter chromosomes are either dumb-bell shaped, or cubical or spherical masses, frequently with a slender process of chromatin running from each daughter chromosome toward the other, figs. 13–15 and text fig. I. A little later each chromosome becomes cubical or quatrefoil in shape, and this form persists, and is universal until the metaphase of the second maturation division, when all become 4-parted, figs. 16–31 and text fig. II, and then cross shaped exactly as in the first maturation. In this case, however, the arms of the cross are not split longitudinally, but the separation takes place between the arms, so that in the metakinesis two of the arms or spherules, in the form of a dumb-bell, go to one pole and two to the other, text fig. II, 5 and 6. In the anaphase of the second maturation, these dumb-bell or rod-shaped chromosomes again become cubical or spherical, as in the anaphase of the first maturation (Plate II, figs. 32, 33 and text fig. II, 8).

The cubical chromosomes at the close of the first maturation are about half as large as the fully-formed chromosomes in the metaphase of that division, while those in the anaphase of the second maturation are about one-half the size of those in the prophase of this division, *i. e.*, the volume of each chromosome at the end of the second maturation division is about one-quarter that of the fully-formed chromosome in the metaphase of the first maturation. There has been therefore no growth of the chromosomes after the metaphase of the first maturation. The number of chromosomes in the second maturation division is the same as in the first, viz. thirty, and the same number is left in the egg after the second polar body has been formed.

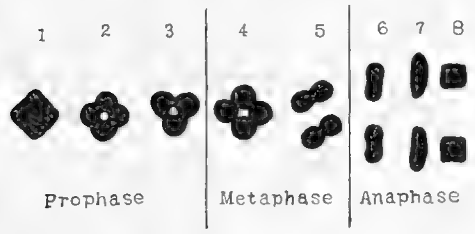

FIG. II.—Chromosomes of the Second Maturation Division of Crepidula. (In the reproduction this figure has been reduced more than fig. I.)

It is especially noteworthy that in the prophase and anaphase of both maturation divisions the chromosomes are cubical or quatrefoil in shape. In the metaphase of the second maturation, figs. 27–31 and text fig. II, the chromosomes look like typical "tetrads" and they would undoubtedly be called such if they occurred in the first maturation.

Similar 4-parted chromosomes in the second maturation are figured by v. Klinckowström ('96) in *Prostheceraeus*, by Van der Stricht ('98) in *Thysanozoon*, and by Byrnes ('99) in *Limax*.

In *Crepidula* it is impossible to say whether the plane of division of the chromosomes is the same or is different in the two maturation divisions. At the beginning and at the end of both divisions the chromosomes are cubical or quatrefoil in shape, and one might as well speak of the "longitudinal" or "transverse" division of a cube or sphere as of these chromosomes. It is impossible, therefore, to determine whether or not reduction in the sense of Weismann takes place in this case.

Griffin points out that the division of the tetrad in *Thalassema* and *Zirphæa* is unlike that in the Copepods, in that in the former each spherule of the tetrad becomes an arm of a cross and that these arms then split longitudinally, whereas in the Copepod type two entire spherules separate from the other two. The former he calls a "spurious tetrad" (cross form), the latter a "tetrad of the Copepod type." In *Crepidula*, just as in *Thalassema* and *Zirphæa*, the tetrads are of the "spurious" type in the first maturation, whereas in the second maturation we have chromosomes which, in every respect, resemble tetrads of the Copepod type.

In the late anaphase of the second maturation the chromosomes which remain in the egg become vesicular and fuse together to form a few vesicles with large granules of chromatin on their walls, Plate II, figs. 34–35. Finally all of these vesicles fuse into one, as is shown in fig. 36, *et seq.*

2. Centrosomes and Central Spindles.—The earliest stage at which centrosomes have been seen was in an egg from the oviduct, not yet fertilized, fig. 2. In this egg the centrosomes are already present as two minute bodies, in contact with the nucleus and without any apparent central spindle or polar radiations. In fact, because of the absence of these radiations it is impossible to be certain that the two granules shown in fig. 2 are really centrosomes. In other eggs from the oviduct, figs. 3–7, into which a spermatozoon has penetrated, the centrosomes are larger, a central spindle is present and polar fibres are abundant. I have been unable to determine whether this central spindle arises as a centrodesmus (Heidenhain) or whether its fibres grow out independently from the two centrosomes and afterwards unite to form the spindle. In general it may be said, that the formation of the mitotic figure usually begins with the entrance of a spermatozoon into the egg.

In the prophase of the first maturation the centrosomes are minute densely staining points; they grow larger as mitosis advances, and in the stages immediately preceding the metaphase, figs. 8, 8*a*, 11, and text fig. III, they are more or less irregular in shape, and when deeply stained and strongly destained with the iron-alum-haematoxylin of Heidenhain, they may be seen to contain a central clear area. Around this clear area the dense walls of the centrosome are thickened in places and may, perhaps, represent large granules in contact with one another, as Lillie has found to be the case in *Unio*. In the prophase of the second maturation, the centrosomes are so small that I have found it impossible to make out their structure with certainty, but they are in many cases slightly irregular in form (cf. figs. 27–31), from which I conclude that their structure is the same as in the prophase of the first maturation.

In the metaphase of the first maturation (fig. 12), the centrosomes are spherical bodies about 1 μ in diameter. They contain a central area which stains faintly, around which is a thick, dense zone which corresponds to the irregular or granular zone of the prophase; in the metaphase, however, this zone is perfectly regular and gives no indication of being composed of granules as in the preceding stage.

In the anaphase of the first maturation the centrosomes become large hollow spheres, the peripheries of which stain deeply while their central areas remain

clear. Within the central area a faintly staining body becomes visible, which, in its turn, becomes a hollow sphere (text fig. III, *e* and *f*); this is the "corpuscle central" of Van Beneden ('87), or the "centriole" of Boveri ('95).[1]

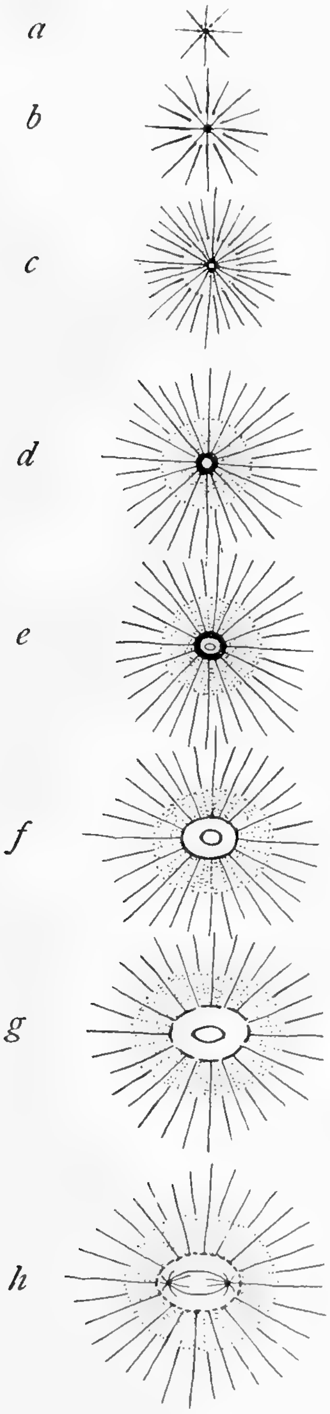

FIG. III.—Centrosomal Cycle in the Maturation of Crepidula.

Up to this stage the centrosomes at the two poles of the maturation spindle are identical in size and structure. When, however, the outer pole of the spindle comes into contact with the egg membrane, the sphere and centrosome at this pole become flattened, figs. 14–16, though the centrosome still shows its dark periphery, its central clear area and its central corpuscle.[2] In the late anaphase the outlines of the centrosome at the outer pole are marked by a layer of granules, while within the central clear area is the elongated central corpuscle, fig. 16*a*. Finally, after the complete separation of the first polar body, the granular outlines of this centrosome disappear, though the central corpuscle, or rather the centrosomes and central spindle to which it gives rise, are still found within it (Plate II, figs. 22, 28*a*, 29, 34, 36).

The centrosome at the inner pole of the spindle continues to enlarge until it reaches a truly astonishing size, becoming fully 4 μ in diameter. Its peripheral layer is at first a solid zone of deeply staining material. In later stages this zone breaks up into plates, figs. 16–25 and text fig. III, and still later it appears as a ring of close set granules.

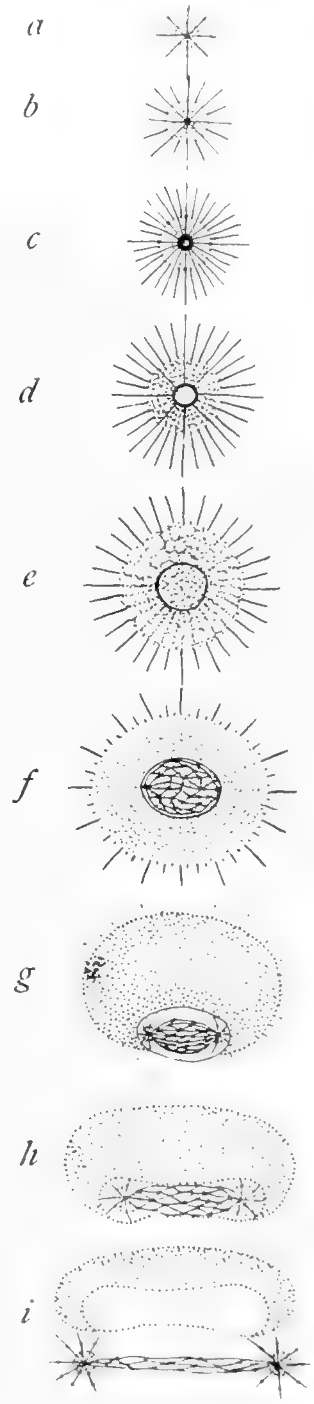

FIG. IV.—Centrosomal Cycle in the Cleavage of Crepidula.

[1] Boveri ('01) denies the general homology of his "centriole" with the "corpuscle central" of Van Beneden. There can be no doubt that the structure in question in *Crepidula* is homologous with Boveri's "centriole."

[2] Van der Stricht ('98) has observed a similar flattening of the sphere and centrosome against the egg membrane in the first maturation of *Thysanozoon*.

The central corpuscle, which is shown in figs. 13 and 14 as a faintly staining, hollow sphere, soon becomes elliptical in shape, fig. 15. At the poles of this ellipse its walls grow thicker and stain deeply. These thickened points become the centrosomes of the second maturation spindle, while the remainder of the ellipse forms the central spindle[1] (cf. figs. 14-16*a*, and text fig. III, *g*, *h*). The daughter centrosomes and central spindle lie within the mother centrosome; the outlines of the mother centrosome then disappear and the new amphiaster lies free in the granular remains of the sphere.

During this metamorphosis the centrosome undergoes great changes in its staining qualities; in the prophase and metaphase it stains deeply with hæmatoxylin; as it enlarges, however, the peripheral portion only takes hæmatoxylin, while the central part takes plasma stains; finally, in the late anaphase, even the peripheral portion takes plasma stains.

At no time during this metamorphosis do the astral radiations penetrate the centrosome. As long as they can be seen they remain attached to its surface, and even after the new amphiaster has arisen within the mother centrosome, the rays are still centered on the figure as a whole, figs. 25–28, and text fig. III, *g* and *h*. The new radiations which appear around the daughter centrosomes develop *de novo*, as MacFarland ('97) and Griffin ('99) maintain.

Up to the time when the second polar body is cut off, the history of the centrosomes during the second maturation is similar to that already described for the first; at the beginning of division they are minute granules, as the division advances they become larger, and in the anaphase are large hollow spheres.

After the second polar body has been formed, however, the centrosome which remains in the egg becomes a very large sphere filled with many coarse granules and with a boundary layer of close-set granules, from which, in some cases, polar fibres proceed, figs. 34–36. I have never seen a peculiarly large granule which might be regarded as a centriole within this centrosome, nor have I seen the formation of a central spindle as at the close of the first maturation. On the other hand, the formation of a large number of granules within the centrosome is a phenomenon which occurs in the telophase of every cleavage (text fig. IV), and seems, therefore, to be the more usual process. It seems probable, therefore, that the particular manner in which the daughter centrosomes and central spindle arise within the mother centrosome at the close of the first maturation, is a modification of the more typical process shown in the cleavage, due, perhaps, to the entire omission of a resting stage between the two maturation divisions. In the maturation, there-

[1] In view of the remarkable resemblance of this stage to a corresponding stage in the division of the "centrosome" in *Diaulula* (see MacFarland's figs. 36, 37, *et seq.*) it may be supposed that the vesicular body which I have called the "central corpuscle" is really the centrosome and that the surrounding body is only the inner zone of the sphere. Fortunately, however, the outlines of the centrosome are so perfectly distinct and its history, as shown in my preparations, so continuous, that there can be no question as to its identity in this case. The outlines of the old centrosome remain until after the central corpuscle has given rise to a perfect spindle within it; so that in *Crepidula*, and several other gasteropods which I have studied, the new centers and central spindle arise from the central corpuscle and not from the entire centrosome as in *Diaulula*.

fore, the centrosomes, like the chromosomes, undergo an unusual type of division. The centrosome which goes into the second polar body completely disappears.

The egg centrosome is surrounded by a sphere with grows with the growth of the centrosome until it becomes very large and is filled with faintly staining granules which are held in a delicate reticulum, fig. 36. In some cases the outlines of this sphere are very distinct, in others more faint, but in all cases there are strongly marked polar fibres, which run from the periphery of the sphere for a considerable distance through the egg; some of these fibres may also be traced into the spheres where they appear to break up into rows of granules. In stages later than fig. 36 I am unable to recognize the egg centrosome; its granules merge with those of the surrounding sphere and its outlines are no longer visible.

In structure and metamorphosis the centrosomes of the maturation divisions of *Crepidula* are very similar to those described by MacFarland ('97) in *Diaulula*, Lillie ('98) in *Unio*, Vejdovsky and Mrazek ('98) in *Rhynchelmis* and Van der Stricht ('98) in *Thysanozoon*. The further consideration of these centrosomes will be deferred until after the description of the cleavage.

3. Polar Rays, Spindle Fibres and Spheres.—At the time of the entrance of the spermatozoon into the egg, figs. 3 and 4, the centrosomes are surrounded by polar fibres and the nuclear membrane is indented in the region of each centrosome. A large number of fibres, forming a cone or half spindle, can be traced from each centrosome to the indented portion of the nuclear membrane. Within the nucleus the linin threads, with their attached chromatin granules, are arranged in the same radiating lines as these fibres and form an intranuclear continuation of them, figs. 3 and 4.

In early stages of this division both the extra- and intra-nuclear portions of the spindle consist of branching and anastomosing threads, along which are ranged oxychromatin granules. These two groups of fibres, *i. e.*, those inside and those outside of the nucleus, are so essentially alike that I cannot doubt that both are derived from the same substance, viz., the linin and oxychromatin of the nucleus, in which case the extra-nuclear portion of the spindle must be formed from nuclear constituents which have escaped from the nucleus at the indented areas mentioned above.

The polar fibres also consist of threads along which granules are attached, figs. 4, 5 and 6. In the first maturation they closely resemble the spindle fibres, and, like them, may be derived from the achromatic nuclear substance. These granules are rarely arranged in concentric spheres as Heidenhain, Drüner and Lillie have found them. As mitosis advances, both polar and spindle fibres become smooth. There can scarcely be any doubt that this is accomplished by the transformation of these granules into the substance of the fibre (cf. Boveri, '88, p. 80, Wilson '95, Griffin '99). Again, in the dissolution of the spindle one frequently observes that the fibres become varicose, as in the early stages of mitosis, while the portion of a fibre between granules becomes less and less prominent, figs. 16*a* and 33. I have been unable to observe these same varicosities on the fibres of the central spindle in the maturation divisions, but they can be seen in the central spindles which are found during the cleavage of the egg (Plate IV, figs. 74, 75 and 76, and text fig. IV).

The infolding of the nuclear wall mentioned above must, of course, be accompanied by the escape of some substance from the nucleus. Coincidently with this infolding of the nuclear membrane the polar fibres and extra-nuclear spindle fibres become longer, stouter and granular. At the same time the spindle and the sphere surrounding the centrosome stain more deeply, owing to the presence of an interfilar substance, which stains like nuclear sap.[1] The nuclear membrane then completely disappears, but the nuclear contents preserve for some time the outline of the nucleus and can easily be distinguished from the surrounding cytoplasm because of greater affinity for stains, figs. 6 and 7. The entire mitotic figure, with the exception of the polar systems, lies within this granular area and the enormous growth of the spindle is at the expense of this intra-nuclear substance. Not all of the achromatic substance of the germinal vesicle is confined to the spindle and the polar systems, a large part of it passes directly into the cytoplasm, which is increased in quantity after the nuclear membrane dissolves.

Both the aster and the spindle are plainly composed, during the early stages of mitosis, of two constituents, viz., fibres with their attached granules and an interfilar substance. Between and around the spindle fibres, both in the first maturation and in all subsequent divisions, there is a homogeneous interfilar substance which colors deeply with plasma stains. This substance is sharply delimited from the surrounding cytoplasm, as is shown in figs. 12 and 12*a* and also in later stages of both the maturation and cleavage.

A cross section through the equator of the spindle in the metaphase, fig. 12*a*, shows the interfilar substance of the spindle as a homogeneous mass, staining deeply with orange or eosin, and with stellate radiations running out into the cytoplasm in all directions. These radiations around the equator are shorter, blunter and more irregular than those at the poles. They are probably caused as follows: in the formation of the definitive spindle there is a general elongation of the linin reticulum in the direction of the spindle axis and a contraction of the reticulum at right angles to that axis; at the same time there is a condensation of the interfilar substance, the more fluid karyolymph being squeezed out of the spindle. In this equatorial shrinkage some of the linin threads probably remain attached peripherally and thus cause the stellate radiations.[2] The chromosomes lie within this interfilar substance, though occasionally one is found just outside of it, fig. 12*a*, and they are scattered through the entire thickness of the spindle, and not merely in a wreath around the periphery. There is, therefore, strictly speaking, no "central spindle" in *Crepidula* as contrasted with a "peripheral spindle," but the fibres of the two must be intimately commingled.

[1] Drüner calls attention to the fact that the nuclear membrane is dissolved at points opposite centrosomes and that coincidently the rays grow stronger; and R. Hertwig ('99) has observed in *Actinosphærium* that nuclear material probably escapes into the plasma cones, since the latter stain more deeply about the same time that the nucleus shrinks in size.

[2] Similar radiations around the equator of the spindle have been figured by Korschelt ('95, figs. 131, 139), Mead ('98, fig. 18), and Gardiner ('98, figs. 28, 34).

An interfilar substance, which is to all appearances similar to that of the spindle, surrounds the centrosomes and radiates along the polar fibres, so that in all middle stages of mitosis it is difficult to recognize the polar fibres and spindle fibres when once they are surrounded by it.

In the later stages of mitosis this interfilar substance moves to the poles of the spindle, again allowing the spindle fibres to be seen distinctly; it also moves inward toward the centrosome, leaving the polar fibres sharply marked, fig. 22, and thus aggregated, from the spindle and polar rays, forms a sphere with rather indefinite outlines. This sphere differs notably in character from that which is found in many other animals, e. g., the *outer sphere* of *Unio* (Lillie '98) and the *couche corticale* of *Thysanozoon* (Van der Stricht '98). The latter are clear zones of definite outline, with faintly staining astral rays running through them; in *Crepidula*, on the other hand, this zone is indefinite in outline until the late anaphase or telophase, and is even then not so sharply bounded as Lillie and Van der Stricht have shown it; further, instead of being a zone which is clearer than surrounding parts, it is denser and more deeply staining. The spindle fibres and polar rays can be traced through this sphere to the centrosome in early stages of mitosis, but in middle stages fewer radiating fibres can be seen in it (cf. figs. 3–8*a* with figs. 11–16). In later stages again polar rays can be traced through it to the centrosome (cf. figs. 22–24 and 34–36).

The origin of this interfilar substance is difficult to determine. In the aster it seems to be principally derived from hyaloplasm (interalveolar substance) of the cell body, which is aggregated toward the centrosomes, the larger alveoles of the cytoplasm and the yolk spherules being crowded out from the centrosome as the interalveolar substance moves in toward it. In the spindle, on the other hand, the interfilar substance seems to be formed in large part from achromatic material of the nucleus; such interfilar substance exists before the nuclear membrane is broken, though it is at this stage much less dense than in the fully formed spindle. When the nuclear membrane dissolves at the poles this substance escapes into the extra nuclear spindle and spheres; it is quite possible that at the same time there may be an invasion of the spheres and spindle by hyaloplasm from the cell, this double movement being in the nature of a diffusion in both directions. The fact that the interfilar substance is denser than either the nuclear sap or hyaloplasm may perhaps indicate that it is a new substance formed by a combination of the two. While this suggestion as to the origin of the interfilar substance accords well with all my observations as to its character and movements, it cannot be considered as more than a suggestion.

The form and size of the first maturation spindle varies greatly in different phases. From the prophase to the metaphase it increases in length and diameter, becoming most stout in the metaphase; in the early anaphase it continues to increase in length, becoming about as long as the radius of the egg, figs. 11–14, and at the same time it grows very slender; finally, in the late anaphase it again shortens, becoming stouter, until it is not more than one-half as long as in the metaphase or early anaphase, figs. 15 and 16, and at the same time the chromosomes are pushed

right into and through the sphere until they come into contact with the cell wall. In no other mitosis is there such a shortening of the spindle; in fact, in all other divisions, with the possible exception of the second maturation, the spindle continues to grow longer throughout the whole of the mitosis. A similar shortening of the first maturation spindle has been observed in *Ascaris* (Boveri '87), *Branchipus* (Brauer '92), *Ophryotrocha* (Korschelt '95), *Myzostomum* (Wheeler '95), *Cerebratulus* (Coe '99), *Polychærus* (Gardiner '98), *Axolotl* and *Triton* (Carnoy and Lebrun '99, see their figs. 110 and 112). The principal cause of this shortening is to be found in the peripheral movement of the mitotic figure, as will be described in Part II; its chief result is the production of a much smaller polar body than would be possible if the spindle maintained its maximum length throughout the later stages of division. At the time of its greatest length the first maturation spindle is about one-half as long as the diameter of the egg, and since the division of the cell body always takes place through the middle of the spindle, the first polar body would have a diameter one-quarter that of the egg were it not for this shortening of the spindle.

I agree with G. Niessing ('99), that the shape of the spindle, *i.e.*, whether it is stout or slender, is due to the quantity and location of the interfilar substance, but this depends upon the degree of contraction of the linin reticulum. Both reticulum and interfilar substance are widely distributed through the nuclear cavity in the early prophase, and at this stage the spindle is very stout; in later stages, as the reticulum contracts and the interfilar substance passes to the poles, the spindle grows slenderer. In the late anaphase, when the spindle becomes shorter, it again grows stouter, figs. 15 and 16.

The second maturation spindle arises within the centrosome left in the egg at the close of the first maturation. At first it occupies but a small part of the cavity of this centrosome, but it grows rapidly until it fills the whole of it. The outlines of the mother centrosome then disappear and the spindle lies free in the sphere substance. Here it grows rapidly in size, but never becomes more than half as long as the first maturation spindle, though it is relatively stouter. Its mantle fibres are not formed directly from a linin reticulum, since there is no vesicular nucleus, though they may possibly be formed from nuclear material which escaped from the germinal vesicle at the previous division.

During the prophase, the direction of the first maturation spindle bears no constant relation to the egg axis. It may lie obliquely or even at right angles to that axis, figs. 9 and 10, but ultimately it moves into a radial position, fig. 12, *et seq.*

The direction of the second maturation spindle, like that of the first, varies greatly, though in all cases it ultimately becomes approximately radial. As in *Physa* (Kostanecki and Wierzejski '96), the outer pole of the second maturation spindle lies at the very point where the mid-body (*Zwischenkörper*) of the first maturation spindle was formed. The second polar body is given off immediately under the first, so that the latter becomes separated from the surface of the egg and remains mounted upon the former. This happens irrespective of the initial direc-

tion of the spindle, which always ultimately turns so that one pole lies immediately under the first polar body. If one may judge by the figures of many authors, this must be a phenomenon which occurs among a large number of animals.

4. Polar Bodies.—Finally, the outer half of the mitotic figure, with a small amount of surrounding cytoplasm, protrudes from the general surface of the egg. The furrow separating the first polar body begins to form at the periphery and proceeds toward the middle of the stalk connecting the polar body with the egg. In some cases the spindle seems to retain its full diameter, even when the cytoplasm has been completely constricted by the dividing furrow, fig. 22, as has also been observed by Kostanecki and Wierzejsky ('96) in *Physa*. Afterward, the spindle itself becomes constricted in the middle, fig. 23; and the constricting ring of darkly staining substance finally cuts the spindle in two and itself becomes a spherical mid-body. During and after the separation of the first polar body, one first becomes aware of the fact that there is an egg membrane, which takes no part in the constriction, but is lifted from the egg by the polar body, Plate II, figs. 22, 23, 28, 30 and 31.

The second polar body is smaller than the first and is separated from the egg in the same way as the first, a mid-body being formed, as shown in figs. 34 to 41. This mid-body is larger and persists longer than that of the first maturation, as Mark and Kostanecki and Wierzejski have also observed. When fully developed, it consists of a central granule and two surrounding spheres, the inner one small, dense and sharp in outline, the outer one large, less dense and indistinct in outline. The remains of the spindle can be seen running through this outer sphere as two cones, their apices being in contact with the inner sphere and their bases with the two nuclei.

The first polar body divides by mitosis into two, figs. 27, 28*a*, 32, 34 and 36, and each of these may subdivide amitotically into a large number of cells, some of which are unequal in size and recall the macromeres and micromeres of developing ova, figs. 41, 45, 61, 69, 73 and 81. I have never seen the second polar body dividing.

II. Fertilization.

1. Entrance of Spermatozoon.—Copulation occurs only at long intervals, perhaps once in the life time of a female, and the spermatozoa are stored after copulation in a tubular outgrowth of the uterus. Ova and spermatozoa meet in the uterus, and here the entrance of the spermatozoon occurs, though the later stages in the approach of the egg and sperm nuclei do not occur until after the capsules have been formed and deposited. In the examination of thousands of eggs taken from the egg capsules I have never found one which was unfertilized and very few into which more than one spermatozoon had entered.

A mature spermatozoon is shown in fig. 17; there is a relatively large head with pointed apex, separated, in preserved material, by a clear space from the tail. I am inclined to regard a minute, darkly staining cap which covers the posterior end of the head as the middle piece. It is extremely small and appears to contain no

archoplasm.[1] A spermatozoon enters the ovum almost immediately after it reaches the uterus and while the germinal vesicle is still intact, fig. 3, *et seq*. The sperm may enter at any point on the surface of the egg, except within a small area immediately surrounding the animal pole; usually, however, it enters near the vegetal pole. Polyspermy is exceedingly rare; one sometimes finds several spermatozoa attached to an egg, and in a few cases two spermatozoa may be found penetrating the egg membrane or lying just within it, fig. 10, but only on one or two occasions have I seen two well-developed sperm nuclei within one egg. The pointed head of the spermatozoon bores through the egg membrane, figs. 18, 19, 20, though the tail does not enter. After the sperm head is well through the egg membrane several granules are found just behind the head; these are probably derived from the middle piece. Their number and arrangement is variable, but there are always more than two, so far as I have observed, and they are never grouped at the poles of a spindle. After its entrance, the head occupies such positions as to justify the belief that it turns around, as is known to be the case in many other animals (cf. figs 18, 19, 20, 21).

Foot ('94 and '97) has described in *Allolobophora* a number of dark round bodies which stain as intensely as the sperm head itself, and which lie on each side of the head or at its posterior end. These she calls the *sperm granules* and suggests that they may be formed from metamorphosed archoplasm. They are not constant in appearance and may be the result of degeneration.

Byrnes ('99) has also observed in *Limax* a number of darkly staining granules which accompany the sperm head. She suggests that they are derived from particles of chromatin constricted off from the sperm nucleus. Later they disappear and become scattered through the cytoplasm of the egg.

In the main the resemblance of these "sperm granules," both of *Allolobophora* and *Limax*, to those which I have observed in *Crepidula*, is striking enough. I cannot believe, however, that they are degeneration products in *Crepidula* and for that reason, among others, have not adopted Foot's name for them.

2. The Germ Nuclei.—Immediately after the sperm head has entered the egg it is seen to be a pointed rod with three constrictions and four enlargements, having much the same size and shape as one of the 4-part chromosomes found in the metaphase of the first maturation division, fig. 18. It soon grows shorter and thicker and becomes dumb-bell shaped, fig. 20, then nearly spherical, figs. 10, 21, and then irregular or amœboid, figs. 39, 40. Up to this stage it has remained chromatic throughout, but from this time forward spaces filled with achromatic substance appear within it and it begins to grow vesicular. V. Klinckowström ('96) and Van der Stricht ('98) have observed a similar transformation of the sperm nucleus in *Prostheceraeus* and in *Thysanozoon*, the sperm head being first moniliform, then spherical, then vesicular.

[1] Byrnes ('99) finds no middle piece in the spermatozoon of *Limax* and suggests that it may possibly be surrounded or overgrown by the sperm head.

The egg nucleus is formed by the fusion of the chromosomal vesicles left in the egg at the close of the second maturation, as described on p. 14.

The further changes of the germ nuclei may now be briefly followed as far as the prophase of the first cleavage. The developments of both germ nuclei are entirely parallel, so that a single description will serve for both. As soon as the vesicular stage of each nucleus is reached the chromatin is found to be stretched through the nucleus in the form of a reticulum, figs. 36–41. As the nuclei enlarge the chromatin takes more and more the form of rounded masses, Plate III, figs. 44, 45 and 46, while the reticulum connecting the masses becomes extremely tenuous and does not stain. In short, there is at first a *chromatin* reticulum, which in later stages becomes a *linin* reticulum with the chromatin aggregated at nodal points. The chromatin masses differ considerably in size, fig. 45, and are at first quite solid. In later stages, figs. 49–53, these masses become hollow spherules. Those spherules which develop into chromosomes become connected together into a linear series, and either remain solid or at least have thicker walls than those spherules which take no part in the formation of the chromosomes. The further history of the chromatin will be taken up under the head of the first cleavage. As soon as the vesicular stage of each germ nucleus is reached there appears within it a single large nucleolus.[1] This persists until a stage when the two nuclei come into contact, fig. 44, when it is usually dissolved in the nuclear sap, though sometimes traces of the nucleoli may be seen in later stages, *e.g.*, fig. 49.

3. Egg and Sperm Asters and Spheres.—The history of the egg centrosome and sphere in the second maturation division has already been considered, pp. 16 and 17. At the same time that the egg aster is being transformed into the enormous egg sphere, figs. 32–36, a sperm aster has appeared and is undergoing a parallel transformation. The various stages in this process occur at approximately the same time in the two, though the sperm sphere and nucleus remain slightly smaller than those of the egg until the nuclei lie near each other. We may now follow in detail the origin of the sperm sphere.

After its entrance the sperm head lies among the yolk spheres in a small quantity of cytoplasm, while the granules derived from the middle piece lie just behind the head. There is at this stage no trace of astral radiations anywhere in the egg, except in connection with the first maturation spindle. The sperm nucleus lies in this position, near the periphery of the egg, without any trace of astral radiations near it, until the anaphase of the second maturation division. At this time the nucleus has become irregular or amœboid in shape and some distance from the nucleus, toward the center of the egg, the sperm aster appears. It is a noteworthy fact that no sperm aster appears until the sperm nucleus begins to absorb achromatic material, and this suggests that the two processes stand in some causal relation to each other. Furthermore, the fact that the two spheres are proportional in size to their nuclei, and that the sperm sphere remains smaller than

[1] Mark ('81) observed in an undetermined species of *Limax* that each of the germ nuclei contained a single nucleolus.

the egg sphere as long as the sperm nucleus is smaller than that of the egg, lends further weight to this suggestion.

The earliest stage in the formation of the sperm aster which I have seen is shown in figs. 39 and 40. I have examined thousands of eggs of earlier stages, but have failed to find a sperm aster in any of them. The aster when first seen is a radiating figure in the cytoplasm, with several dark granules at its center. The number, position and size of these granules is not constant, and in later stages they greatly increase in number and stain less darkly than at first; there can be little doubt that they are identical with the granules derived from the middle piece. The sperm aster with the granules at its center ultimately becomes more rounded in outline and forms a large sphere from which radiating fibers proceed in all directions. This sphere exactly resembles the sphere in contact with the egg nucleus, fig. 41.

From the time of their first appearance each of these spheres lies close to its own nucleus, and they do not wander from these relative positions so that there is no possibility of confusing or mistaking them. During the approach of the sperm nucleus and aster to those of the egg, one or two small accessory asters appear in the egg, usually at some distance from the sperm and egg nuclei (figs. 42 and 43); these resemble the minute asters described by Mead ('98), and Lillie ('98) as "accessory asters." They contain no centrosomes or large granules, and their origin at a distance from the egg and sperm asters shows that they are independent of either of these. These accessory asters are present for a brief period only and then completely disappear.

At no stage in their development do the egg and sperm spheres show the compact and densely staining qualities which the spheres show throughout the cleavage stages; this added to the fact that there is a less perfect separation of cytoplasm and yolk during the fertilization than in the cleavage makes the study of these structures difficult, and this is especially true in the stages just before and after the fusion of the spheres. While designating these structures "spheres," both because of their form and also because of the derivation of the egg sphere from the sphere left in the egg at the close of the second maturation, I would not be understood as positively homologising them with the "outer sphere" or "cortical zone" of authors.

4. Approach of Germ Nuclei and Spheres.—The egg nucleus and sphere remain at the upper pole, immediately beneath the polar bodies, and do not move from this position. The sperm nucleus and sphere move toward those of the egg in a path which is at first directed toward the center of the egg ("Entrance path," Roux), and then toward the egg nucleus ("Copulation path"). If the sperm enters near the lower pole, the course of the sperm elements is nearly straight through the egg from the lower to the upper pole; if it enters at any other point than the vegetal pole, the path is a curved one, the "entrance path" curving more or less sharply into the "copulation path," depending upon the distance of the point of entrance from the vegetal pole. In all cases the sperm elements approach those of

the egg from the lower side, and during the prophase of the first cleavage the germ nuclei usually, though not invariably, occupy the same relative positions, the egg nucleus being above and the sperm nucleus below, figs. 42–55. The positions of the spheres relative to the germ nuclei is not perfectly constant, though the sperm sphere usually precedes the sperm nucleus and the egg sphere lies on the central side of the egg nucleus. The spheres remain distinct during the approach of the germ nuclei, one being quite as evident as the other, and neither showing any trace of degeneration. A number of yolk spherules are carried before the sperm into the protoplasmic area surrounding the egg nucleus and sphere, and thus it happens that several yolk spherules are usually found between the two germ nuclei and spheres, and more or less isolated from the remainder of the yolk. The germ nuclei first come into contact, as shown in figs. 44 and 45, and afterwards the spheres meet, inclosing still some of the yolk between them; the spheres then completely fuse, figs. 45, 46, 47, 49, 50, 51, *FS*.

Before fusion the spheres consist of masses of faintly staining granules, and a more or less distinct boundary line separates them from the remaining cytoplasm; from this boundary a few fibres or rows of microsomes radiate. This boundary line is sharper in some cases than in others, but is always faintly marked. Immediately before and after the fusion of the spheres it can be seen that the coarse granules in the spheres are nodal points in a very delicate reticulum, figs. 45–47 and 49–51. As soon as the spheres have fused, their substance surrounds the nuclei and spreads in a faintly staining mass into the cytoplasm above the nuclei and immediately below the polar bodies. A similar area of darkly stained protoplasm has been observed by Coe ('99) in *Cerebratulus* (see his figs. 23–28), and is said by him to be derived from the germinal vesicle. In *Crepidula* there can be no doubt that this area is derived from the egg and sperm spheres, though these in turn may be derived from material escaped from the germinal vesicle. All this time very faint radiations proceed from the periphery of the fused spheres, figs. 46, 49, 50. In *Arenicola*, according to Child ('98), the germ nuclei, when they meet, are surrounded by an area of reticular cytoplasm from which radiations run into the surrounding substance of the egg. Child regards these radiations as possibly the result of the absorption of liquid by the germ nuclei, while the reticulum, he thinks, may indicate an accumulation of liquid around the nuclei.

In *Crepidula* the spheres are present during the period when the germ nuclei are growing most actively; they lie in close contact with these nuclei and appear to be associated with their rapid growth. I am inclined to regard them as the expression of certain chemical and physical processes, taking place between the nuclei and the cytoplasm, rather than as structures of high morphological significance.

5. Origin of Cleavage Centrosomes.—In several cases I have observed two large granules among the microsomes at the periphery of the spheres, from which stronger radiations proceed into the cytoplasm, but not into the spheres, figs. 47, 50, 51. These granules are but little larger than others in the peripheral layer of the spheres, and the radiations proceeding from them are but a trifle stronger and more

perfectly centered. Nevertheless they are the only structures in the egg at this stage which at all resemble centrosomes, and I believe, though I cannot positively affirm it, that they become the centrosomes of the first cleavage spindle. In a slightly more advanced stage, figs. 48, 52, 53, unmistakable centrosomes are present; they are no larger than the granules of the preceding stage, but the radiations are larger and more numerous, and they proceed in all directions from them. Those radiating fibres which are directed toward the germ nuclei come into contact with the nuclear membrane, which becomes infolded at this point, and at the same time a darkly staining, homogeneous fluid escapes from the nucleus thus forming a cone or half spindle, the base of which is applied to the nucleus, while the apex reaches to and surrounds the centrosome.

As soon as the undoubted centrosomes appear the fused egg and sperm spheres lose their boundaries, and their granules are either dissolved, or are scattered through the cytoplasm, figs. 48, 52, 53. The cleavage centrosomes are from the first independent of each other, and not until a later stage (figs. 54 and 55), is there any trace of a "central spindle" between them; these fibres grow out from each centrosome until they meet and fuse, just as MacFarland ('97) has observed in the first cleavage of *Pleurophylidia*.

In view of the controversy as to the origin of the cleavage centrosomes in different animals, it is important to know what relation these centrosomes bear to the egg and sperm spheres of *Crepidula*. Unfortunately no conclusive answer can be given to this question since the centrosomes do not appear until after the spheres have fused.[1] There are certain evidences, however, which point to the conclusion that each sphere gives rise to one of these centrosomes. The evidences are the following:—(1) in fig. 45 a number of yolk spherules lie between the egg and sperm spheres which are here entirely separate; in figs. 46 and 47, the principal mass of yolk within the fused spheres probably marks the line of fusion between the two spheres; in fig. 47 a centrosome lies on each side of the principal aggregation of these yolk spherules, and therefore it is probable that one centrosome has arisen from that part of the fused sphere which was the sperm sphere, and the other from the half which was the egg sphere; (2) until the time of fusion each sphere is closely connected with, in fact partially surrounds, its own nucleus. Even after the fusion it can be seen, fig. 46, that a denser portion of the fused sphere is connected with each of the germ nuclei. Now, if the centrosomes arose, one from the egg

[1] Since this was written more recent work on this subject has shown conclusively that centrosomes and spindles may arise separately in connection with each germ nucleus. If the recently fertilized eggs of *C. plana* are put into a 1 per cent. solution of sodium chloride in normal sea water for 4 hours, a perfect karyokinetic spindle, though about one-half the size of the usual cleavage spindle, appears in connection with the egg nucleus, although the latter may be separated from the sperm nucleus by almost the whole diameter of the egg. If the sperm nucleus is small and densely chromatic no spindle is formed in connection with it; if, however, the sperm nucleus has grown until it contains a considerable quantity of achromatic material a perfect spindle may be formed in connection with it also; in such cases the two spindles usually lie close to each other and may form a tetraster. This experiment suggests that the contradictory observations of different investigators on different animals may find an explanation in the varying rates of growth of the germ nuclei within the egg or in slight differences of the environment.

sphere, the other from the sperm sphere, we should expect to find a centrosome in connection with each germ nucleus and with no connecting central spindle between them. This is just what occurs. In figs. 50–51 the two centrosomes are so placed as to suggest that one is related to the egg nucleus and the other to the sperm nucleus, and in figs. 48–53 there can be no doubt about this fact. In no egg examined is there a trace of a central spindle connecting the two centrosomes until after the centrosomes are in their definitive positions and the nuclear membrane is broken down at the poles of the spindle, figs. 54–55. Even though the centrosomes may lie in their definitive positions at an early stage, a thing which sometimes occurs (fig. 52), they are still quite independent, there being no central spindle fibres between them. This evidence, therefore, although not entirely conclusive, is favorable to the view that one of the centrosomes of the first cleavage spindle comes from the egg sphere and the other from the sperm sphere.

Such a conclusion as to the origin of the cleavage centrosomes is at variance with all observations which have been made heretofore,[1] and it is with much hesitation that I bring it forward without being able to demonstrate its truth in the clearest and most satisfactory manner. I have finally determined to publish these observations only after having spent several years in trying to get indisputable evidence upon this point, so far without success. However, the evidence, as far as it goes, points to the conclusion that both egg and sperm spheres contribute to the formation of the cleavage centrosomes.

In view of the fact that, in *Crepidula*, egg and sperm centrosomes and spheres undergo parallel metamorphoses and that both spheres persist until their union, the commonly accepted view that the spermatozoon alone contributes to the cleavage centrosomes seems in this case highly improbable. Further, there is no particle of direct evidence in favor of this view; there is no sperm amphiaster as in many other cases; when the cleavage centrosomes first appear there is no central spindle between them, as would be the case if both were derived from a single sperm centrosome; a centrosome usually appears in connection with each germ nucleus, which is also inexplicable on the supposition that both have come from the spermatozoon. These same facts are equally strong against the supposition that both cleavage centrosomes are derived from the egg centrosome.

On the other hand it is quite possible that both cleavage centrosomes are new formations, *i. e.*, are not directly derived from the egg and sperm centrosomes, but have arisen independently of these and of each other, in the remains of the fused spheres. Apart from the evidence that one centrosome comes from each of the

[1] It most closely resembles the results of Carnoy and Lebrun ('97) on *Ascaris*, though it differs fundamentally from these in that these authors claim that the cleavage centrosomes arise from nucleoli, one of which comes from each of the germ nuclei.

Since the above was written Lillie's (1901) complete paper on the maturation, fertilization and cleavage of *Unio* has appeared, and the account which he gives of the origin of the cleavage centrosomes in that animal is strikingly like my observations as to the origin of these centrosomes in *Crepidula*. In brief he finds that one cleavage centrosome arises in connection with each germ nucleus, that there is no central spindle between them and that they arise near or in the margin of the sphere substance. He does not consider that they are descendants of the egg centrosomes or sperm amphiaster, but that they are egg products of new origin.

spheres, there is no reason to be alleged why both may not be new formations without genetic relationship to egg or sperm centrosomes, except the analogy of the cleavage stages, where a persistence of centrosomes in all stages can be clearly established.

In a former account of the fertilization of *Crepidula* (Conklin '94) I described a form of "Quadrille of the Centers," in some respects similar to that observed by Fol ('91) and Guignard ('91). In this account I expressly stated that I had not seen the centrosomes during the fertilization, but only the egg and sperm "asters." My account of the persistence and approach of both the asters until they come into contact, I am now able to confirm. However, my account of their subsequent division into halves and the union of these halves by pairs to form the cleavage asters was incorrect. Judging by what I have since seen I am convinced that in my former paper I mistook lobulations of the egg and sperm spheres such as are shown in fig. 44, for division of those spheres, and other similar lobulations of the fused spheres, figs. 46–49, for the union of half-spheres to form the cleavage asters.

The present stand of the question of the centrosomes in fertilization is so well known that it demands no extensive treatment here. Following the publications of Fol, Guignard, Blanc and myself, papers on this subject came "fast and furious." Boveri ('95), Wilson and Mathews ('95), Hill ('95) and Reinke ('95), showed that no quadrille occurred in the Echinoderms; Kostanecki and Wierzejski ('96), MacFarland ('97), and more recently Griffin ('99), and Linville (1900), held that it did not occur among mollusks; Guignard's work has failed of confirmation by other writers; Van der Stricht ('95), who held that a quadrille occurred in *Amphioxus*, has been followed by Sobotta ('97), who maintains that there is no quadrille in that animal, and Blanc ('93), who described a form of quadrille in the trout, has been followed by Behrens ('98), who finds that both the cleavage centrosomes in that animal comes from the sperm; and so the quadrille went to its death.

On the other hand Boveri's ('87–92) view that the cleavage centrosomes were introduced by the spermatozoon, and that "*it is the centrosome alone which incites the division of the egg, and is, therefore, the fertilizing element proper*" (Wilson '96, p. 140), was eagerly championed by more than a score of writers; in fact this doctrine was much more cautiously held by Boveri than by many of his followers. However, there has been accumulating a body of evidence to show that the cleavage centrosomes do not, in all cases at least, come from the spermatozoon. Apart from the long known fact that cleavage centrosomes are present in parthenogenetic eggs, many observations have been made on fertilized eggs which tend to show that these centrosomes may come from the egg centrosome or may possibly arise independently of either the egg or sperm centrosomes. I refer particularly to the work of Wheeler, Foot, Mead, Lillie, Child and myself. In almost every case so far observed there is a period, more or less prolonged, during which no centrosomes are visible (cf. Coe, '98, p. 455). In only a few cases is it affirmed that the sperm centrosomes can be traced without a break into the cleavage centrosomes.

So far as the mollusks are concerned there does not seem to be a single case in

which the cleavage centrosomes are undoubtedly derived from the sperm centrosome. As to *Physa*, in which this origin is strenuously maintained, Kostanecki's figures are capable of another interpretation than that which he puts upon them. All of his figures which show the two germ nuclei and the two centrosomes up to the time when the latter have taken their final position at the poles of the nuclei (his fig. 33*a*) show one centrosome in connection with each nucleus and nowhere in these stages is a central spindle shown, except in fig. 30, which shows a single fibre continuous from pole to pole; even in the later stage, fig. 33*a*, there is no central spindle. Further, it is a significant fact that when the egg centrosome disappears the sperm centrosome also disappears (fig. 25–28), while the next stage figured (fig. 30) shows two large and well marked centrosomes, and in fig. 31 one of these lies in close connection with each of the germ nuclei.

In *Pleurophylidia*, according to MacFarland, the sperm asters and centrosomes disappear completely during the formation of the second polar body and for a relatively long period no centrosomes are present. After the germ nuclei are in contact the cleavage centrosomes appear, and since they frequently occupy positions similar to the sperm centers, the author thinks they are derived from these.

In *Unio* Lillie finds that both egg and sperm centrosomes and asters completely disappear and that accessory centrosomes and asters also arise and disappear. Finally the two cleavage centrosomes arise independantly of each other and of any of their predecessors.

In *Limnæa* Linville finds that both egg and sperm centrosomes disappear for a time, but since the cleavage spindle first involves the sperm nucleus, he concludes that the cleavage centrosomes are of spermatic origin. His figures, however, do not bear out this interpretation; fig. 6 shows the incipient cleavage spindle in connection with what is surely the egg nucleus, though he calls it the fused germ nuclei. (so far as I am aware the germ nuclei do not fuse in any mollusk.) Fig. 18, which is one of the earliest of his figures showing the cleavage centrosomes, shows one in connection with each germ nucleus and with no central spindle between them.

Boveri's figure of *Pterotrachea* ('90, fig. 10), which is so widely copied in the text-books, shows one centrosome in connection with each germ nucleus and no central spindle between the two.

In other groups of animals the evidence in favor of Boveri's hypothesis is by no means conclusive, while much positive evidence has been brought against it. Among *Turbellaria* I know of no single case clearly favorable to this view; (cf. Klinckowström '96), Van der Stricht ('98), Gardiner ('99), Van Name ('99). Coe's ('99) work on *Cerebratulus* affords very good evidence that the sperm centers become the cleavage centers in that animal, and the same is true of *Chætopterus* (Mead '97), and of *Thalassema* Griffin ('99). On the other hand Foot ('97) has shown in a convincing manner that the cleavage centrosomes are new formations in *Allolobophora* and Child ('98) holds the same position with regard to *Arenicola*.

If all these accounts are to be believed, therefore, the cleavage centrosomes may come from the sperm, from the egg, or from both, and it is at once apparant that

processes which vary so much can have no fundamental or general significance.[1] And even if all these accounts are not accepted, they show that the problem is a peculiarly difficult and complicated one and that it is still too early to formulate generalizations with regard to it.

The evidence is certainly very convincing that in some cases both of the cleavage centrosomes come from the sperm, but in other cases the evidence that they do not have this origin amounts to a demonstration. This is shown in the clearest possible manner in phenomena of normal and artificial parthenogenesis in which of necessity the cleavage centrosomes must have their origin in the egg. Boveri recognizes parthenogenesis as an exception to his generalization and indicates that in such cases the egg centrosome may not degenerate. This view presupposes a fundamental difference between amphigony and parthenogenesis such as does not actually exist. It is well known that in certain animals the determining causes of amphigonic or parthenogenetic development are slight differences in extrinsic conditions; for example there is no fundamental difference between the ova of the honey bee which develop parthenogenetically and those which are fertilized, and how purely accidental in this case are the causes which determine whether there shall be parthenogenesis or amphigony. There is no world wide distinction between these two methods of development and the differences as to the manner of origin of the cleavage centrosomes cannot be fundamental. If in some species the egg centrosome is capable of being preserved or reorganized, it is certainly quite possible that in others it may not degenerate at all. There is therefore no *a priore* reason for supposing that Boveri's hypothesis is of general application and, as I have already attempted to show, it is not in accord with all the facts.

Certainly when one looks at the problem of fertilization from a general point of view, when one considers the universality of sexual reproduction, when one reflects upon the multitudes of exquisite adaptations which exist for securing the union of egg and sperm he will be loath to believe that the essential feature of fertilization is the addition of a centrosome to the egg cell or the supplying of a stimulus to its development which is not needed in all cases and can as well be supplied by changes in density, salinity, temperature, etc., as by the entrance of a spermatozoon.

III. Cleavage.

I have already described the cell lineage or what may be called the external phenomena of cleavage in *Crepidula* (Conklin '97) and must refer to that paper for any detailed account of that process. I may be permitted here, however, to recall a few of the more important features in the early cleavage. In this gasteropod, as indeed also in all mollusks, the cleavage is of a peculiarly determinate, *i. e.*, constant and differential, character.

The first cleavage is equal and divides the egg into two blastomeres which are approximately anterior and posterior in position; the second cleavage is also equal, dividing the egg into right and left portions, Plate V, figs. 80–88. Not only are the

[1] See foot-note.

four cells thus formed (A, B, C and D,) equal in size, but they each contain about the same quantity of yolk. Two of the cells (B and D) meet at the vegetal pole in a polar furrow, whereas all four cells usually meet in a point at the animal pole.

From these four cells thus formed three groups or "quartettes" of small cells, without yolk, are cut off (Plate VI, figs. 89–96). These three quartettes (1a–1d, 2a–2d, 3a–3d) form the whole of the ectoblast of the embryo. The fourth quartette (4a–4d) consists of large cells containing yolk and one of the cells of this quartette (4d) is the mesentoblast and gives rise to most of the mesoblast and also to the posterior part of the intestine. The other three cells of this quartette (4a, 4b, 4c) are purely entoblastic. The first division of the first quartette (1a–1d) is very unequal, giving rise to four large "cephaloblasts" and four small "trochoblasts" (figs. 93–96). The latter are peculiar in structure and history, being clear and non-granular as compared with the cephaloblasts; they divide but once and grow to a great size, giving rise to parts of the velum and head vesicle. The first subdivision of the cephaloblasts is also unequal (figs. 97, 98), giving rise to four small "apical cells" and four large peripheral ones which become the "basal cells" in the arms of a cross of ectoblastic cells, which lies with its center at the apical pole and one arm in each quadrant (figs. 99, 100). The first division of the second quartette is nearly equal (figs. 96, 97), while at the second division four small cells arise which forms the "tip cells" in the arms of the cross (figs. 96–100).

Now as contrasted with these external phenomena of cleavage, which are chiefly concerned with cell boundaries, the internal phenomena consist of certain cyclical changes in the nucleus, centrosome and cytoplasm, each cycle being in the main like every other, though often differing in details. It is in these internal phenomena that the causes of determinate cleavage must be sought and to a study of these phenomena we now turn.

No sharp line of demarkation can be drawn between the fertilization and the first cleavage, since the two overlap, to a certain extent, in point of time. For convenience, however, we may consider the fertilization ended and the first cleavage begun when the centrosomes have taken their definitive positions at the poles of the incipient mitotic spindle. Such a stage is shown in figs. 54–55.

1. The Nuclear Changes During Cleavage.—*a. Independence of Germ Nuclei.*[1]—Until the metaphase of the first cleavage the chromosomes derived from the two germ nuclei are plainly separated into two groups, one derived from the egg nucleus, the other from the sperm, figs. 55–56, text fig. V. During the metakinesis no such separation is recognizable, but in the late anaphase the chromosomal vesicles fuse together into two groups and as the daughter nuclei become vesicular a partition wall is left between these groups, fig. 60, and text fig. VI. In the telophase this partition wall gradually disappears, persisting longest on the side of the nucleus next the centrosome, where a groove marks its position, fig. 81; this groove usually disappears at the height of the nuclear "rest" or "pause," but it appears again in the early prophase of the next division and in almost exactly

[1] An abstract of this section appeared in the *Biological Bulletin*, Vol. II, 1901.

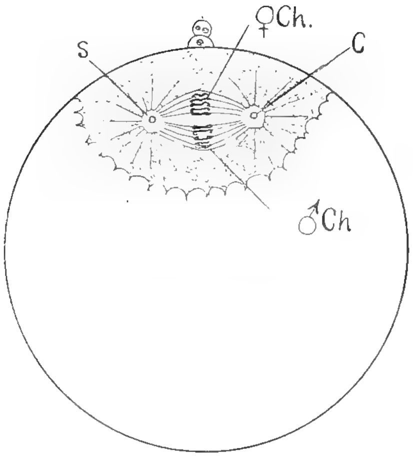

Fig. V.

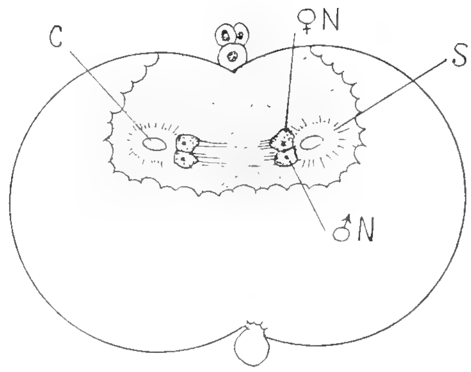

Fig VI.

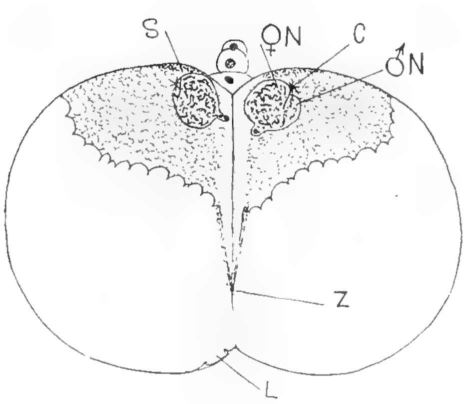

Fig. VII.

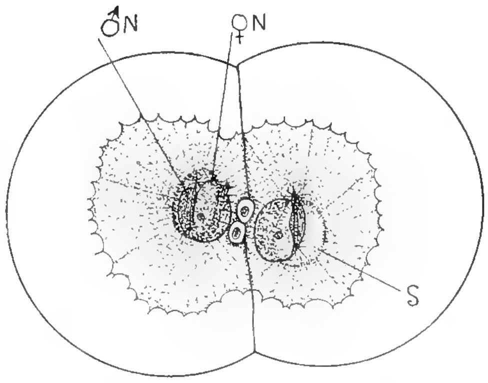

Fig. VIII.

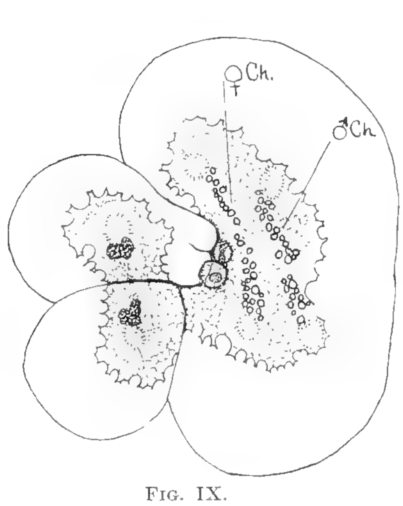

Fig. IX.

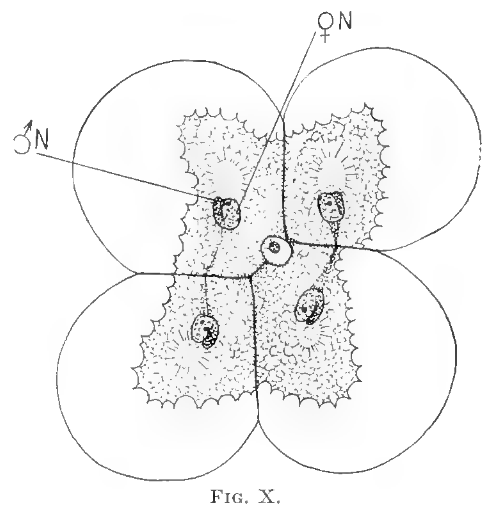

Fig. X.

Figs. V–X.—Independence of the Germ Nuclei of Crepidula.—The duality of each nucleus is shown in the metaphase and telophase of the first cleavage (figs. V, VI), in the prophase and telophase of the second cleavage (figs. VII, VIII, X) and in an abnormal egg (fig. IX).

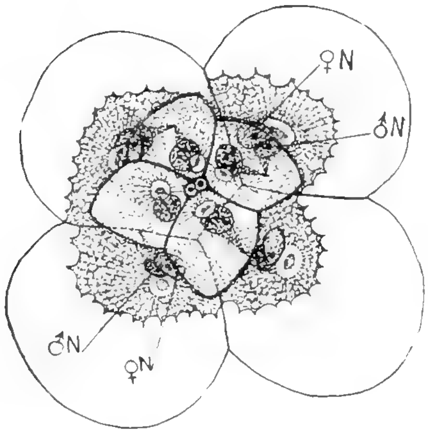

Fig. XI.

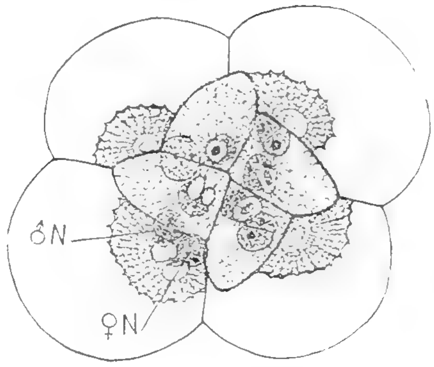

Fig. XII.

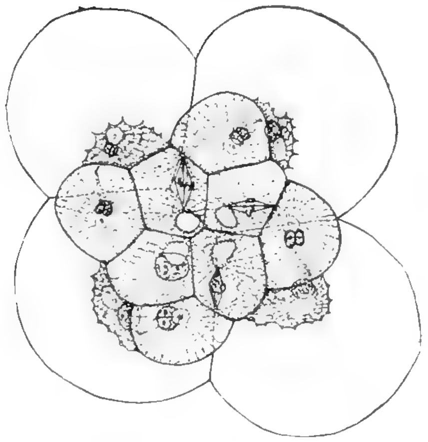

Fig. XIII.

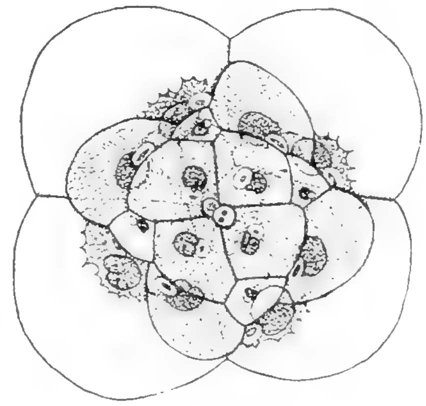

Fig. XIV.

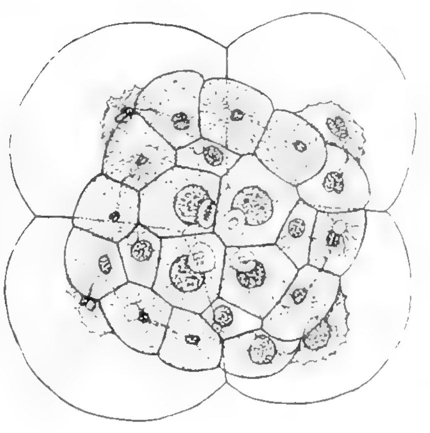

Fig. XV.

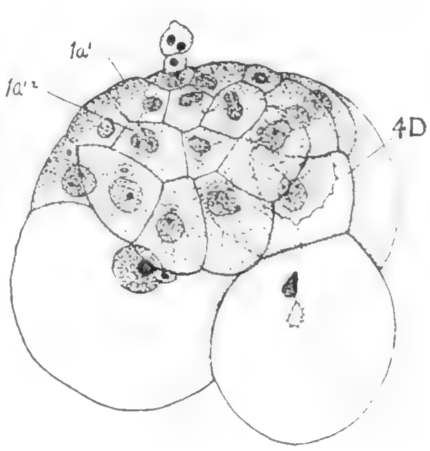

Fig. XVI.

Figs. XI–XVI.—Independence of the Germ Nuclei of Crepidula.—The dual character of each nucleus is shown especially well in the telophase of each division.

the same position in which it was last seen, fig. 82, text figs. VII and VIII. In this groove the new central spindle for the next cleavage lies and in the following division each half of the double nucleus is divided equally, frequently showing a double chromosome plate in the metaphase. In the succeeding anaphase and telophase each nucleus is again plainly double, being separated by a partition wall into two parts. The dual character of the cleavage nuclei has been observed in the telophase of every cleavage cell up to the 29-cell stage and in many cells up to the 60-cell stage, text figs. V–XVI.

It is very probable that the halves of these double nuclei descend in unbroken continuity from each of the germ nuclei and for the following reasons:

1. In the first and second cleavages the nuclear halves are distinct at all stages except during the metakinesis, and the relative positions of these halves correspond to those of the germ nuclei. Even in later cleavages the relative positions of the nuclear halves indicate that the one lying nearest the animal pole is probably from the egg nucleus and the other from the sperm, text figs. V–XVI.

2. In the first, second, third and fourth cleavages, and probably in all, the central spindle when first formed in the early prophase, lies in a groove between the nuclear halves, and hence in the only plane in which it could lie if the nuclear halves are to be equally divided. Since successive cell divisions in *Crepidula* alternate in direction, it follows, if the plane of nuclear division is always at right angles to the plane of contact between the two halves, that the nuclei or nuclear spindles must rotate at every cycle of division. This actually occurs, as a glance at the text figures will show; the rotation usually occurs in each nuclear cycle before the prophase but sometimes as late as the metaphase.

3. In certain abnormal cases blastomeres are found with two entirely separate nuclei in the resting stage; in other cases two entirely separate mitotic figures lie side by side in the same cell and in one such case, text fig. IX, there are thirty chromosomes in each of these spindles, the same number which is found in each of the germ nuclei.

4. Finally there is always a single nucleolus in each of the germ nuclei before their union, and in all of the cleavages, so far as I have observed, there are two and only two nucleoli present in the telophase, but during the resting period, particularly if it be prolonged, they may fuse into a single one. In view of current teaching with regard to the significance of the nucleolus this persistence of a definite number of nucleoli in each telophase is a somewhat surprising fact and may possibly indicate that there is a persistence of some structure which may act as a center for the formation of the nucleolus in each cell generation.[1] Since the nucleolus itself is dissolved at the beginning of each mitosis, may not some achromatic structure, in which or around which the new nucleolus is formed, persist and be transmitted by

[1] Montgomey ('99) has compiled tables showing the number of nucleoli in the egg cells of 170 or more genera representing almost every phylum in the animal kingdom. As a result of this work he concludes that the number is not constant for a species, that it does not depend upon the amount of yolk, mode of cleavage nor upon the manner of deposition of the egg, and that the facts do not warrant an attempt to explain the factors limiting the number of nucleoli.

division to the two daughter cells? However this phenomenon may be explained, the fact that there is a single nucleolus in each germ nucleus before their union, and that there is a single nucleolus in each half of the dual nuclei during the cleavage, is additional evidence that the halves of these dual nuclei actually represent the germ nuclei.[1]

Such a case as that of *Crepidula* indicates that the apparently single vesicular nucleus of the resting stage may really be double in character, and the fact that out of such a nucleus there may arise in the anaphase and telophase dual daughter nuclei shows that the germ nuclei may still preserve their individuality, though no trace of such separateness may be apparent at other periods. Further, it is possible, even in advanced stages of the cleavage to determine with considerable probability which part of a double nucleus is derived from the egg and which from the sperm, the egg half always lying nearer the animal pole than the sperm half (see text figures V–XVI).

This independence of the germ nuclei during the cleavage of *Crepidula* is fundamentally like the observations of Häcker ('92, '95) and Rückert ('95) on *Cyclops;* here also the germ nuclei do not completely fuse throughout the early cleavage, their independence being most clearly shown in the telophase. Rückert also finds evidence of a similar independence of the germ nuclei in the figures of Fol ('79) on *Toxopneustes* and of Bellonci ('84) and Kölliker ('89) on *Siredon*. Some of these figures referred to furnish very doubtful evidence. For example only one of Fol's figures (pl. VII, fig. 7) shows a dual nucleus, while the figure in Kölliker's textbook (fig. 36) is most probably a case of the indentation of the nuclear membrane opposite the centrosomes, a thing which frequently happens in the early prophase. Bellonci's figs. 1 and 20 show an indentation on one side of the nucleus which may correspond to a division between the germ halves, but none of his figures, with the possible exception of fig. 20, show a fusion of the chromosomal vesicles into two separate groups. Coe ('99) figures an indented nucleus in the telophase of the first cleavage of *Cerebratulus* (see his fig. 40) which probably represents the incomplete fusion of the germ nuclei in this animal. With the exception of Häcker and Rückert, none of the authors named call attention to these indented nuclei or suggest their possible significance, and I think it may fairly be said that *Crepidula* affords the most satisfactory and convincing evidence of the independence of the germ nuclei which has yet been discovered.

These observations are intimately related to the important discovery of Herla ('93) and Zoja ('95) that the egg and sperm chromosomes of *Ascaris* remain independent at least as late as the twelve cell stage, and this discovery was anticipated

[1] More recent experimental work on *Crepidula* egg has shown that when the chromosomal vesicles are prevented from fusing a single nucleolus usually appears within each; in general, one nucleolus is found within each nuclear vesicle, and the fact that two are so generally found in the telophase is probably due to the fact that at this stage the nucleus consists of two vesicles, whereas the more complete fusion of these vesicles in later stages may lead to the formation of a single nucleolus. Such a view would bring the size and number of nucleoli into relation with the size and number of nuclear vesicles present at any stage.

by the hypothesis of the individuality of the chromosomes, first advanced by Rabl ('85) and afterward ably defended by Boveri ('87, '88, '92).

(*b*). *Chromatin.* At the beginning of the prophase of the first and second cleavages the nucleus contains a large number of rounded chromatin granules, which are connected together by a faintly staining linin network, figs. 45–55 and 62–64. These granules are at first solid bodies, but later become hollow spherules,[1] figs. 45–52, and in these stages they all stain alike. Some of these spheres then become united in a linear series, to form the chromosomes, while the others (a large proportion of the whole number) take no part in the formation of the chromosomes and are finally dissolved in the nuclear sap, or are transformed into linin threads. Those spherules which enter into the formation of the chromosomes again become solid and stain more deeply than the others (basichromatin) figs. 50, 51, 62, 63, while those which do not form chromosomes stain less deeply with nuclear stains and gradually come to take plasma stains, (oxychromatin.)

In the prophase of the third, fourth and fifth cleavages the chromatin exists in the form of a reticulum, figs. 70, 71, 74, 75, and not in the form of separate spherules. In the rest preceding the prophase, however, this reticulum is formed of chromatin spherules as in the first and second cleavages, though these spherules are never so evident in later cleavages as in the first two. Some of the threads of this chromatin reticulum become chromosomes; others which show that they are composed of granules, fig. 70, stain much less deeply with nuclear stains, finally taking plasma stains only, and have no part in the formation of chromosomes, but are dissolved in the nuclear sap, or are transformed into linin.

This differentiation into two kinds of chromatin, one of which (basichromatin) forms chromosomes and the other (oxychromatin) does not, occurs in the early prophase; in the preceding rest stages all the chromatin, both reticulum and spherules, stains alike, figs. 45–55 and 61–64 and 69–70. In the first and second cleavages the oxychromatin granules are scattered through the whole of the nucleus and most of them dissolve *in situ*, figs. 53, 54, though some of them become attached to the mantle fibres of the spindle, fig. 55, and text figs. XVII and XVIII, where they are either transformed into spindle fibres or are dissolved, exactly as in the prophase of the first maturation. These dissolving granules sometimes remain hollow and in this case their morphology sufficiently identifies them with the chromatin spherules of preceding stages, figs. 49–52; in other eggs the dissolving granules become solid and gradually grow smaller and smaller until they disappear in an almost homogeneous nuclear sap, figs. 53 and 63. In some of the cleavages, particularly the second and third, I have observed that the basichromatin, in the form of a densely staining reticulum occupies that portion of the nucleus lying nearest the centrosome ("Pol" of Rabl '85), while the oxychromatin, also in the form of a reticulum, occupies the opposite half of the nucleus ("Gegenpol" of Rabl), figs. 62

[1] These hollow spherules with clear center and dark periphery directly reverse that common staining phenomenon, such as is characteristic of yolk spheres, where the periphery becomes clear, on destaining, and the center remains dark. They have also been figured by Korschelt ('95) in *Ophryotrocha* and by Coe ('99) in *Cerebratulus* in the prophase of the first cleavage.

and 70. These nuclei are very similar to those figured and described by Calkins ('98) in *Noctiluca* and by R. Hertwig ('99) in *Actinosphærium*, where the basichromatin is aggregated at one pole ("Hauptpol") and the oxychromatin at the other ("Gegenpol").[1]

In all cases the oxychromatin granules or reticulum completely disappear as such, though this may not happen until after the spindle is well formed, e. g., fig. 55. Wilson ('95) maintains that a portion of the chromatin (oxychromatin) is transformed into linin in *Toxopneustes*, and Griffin ('99) holds the same view as to *Thalassema*; see also Lillie (1901, p. 250). I have no doubt that this is the case also in *Crepidula*, where many of the oxychromatin granules are arranged on the linin fibres and are here dissolved and apparently transformed into the substance of the fibres (see text figs. XVII, XVIII). The further history of the achromatic substances will be followed under the head of the mitotic spindle and spheres.

The basichromatin is transformed into chromosomes in the manner already indicated (p. 36). In no nucleus in *Crepidula* have I ever been able to find a single continuous spireme thread. The chromosomes are formed by the union into a linear series of the chromatin spherules or from portions of the chromatin reticulum, but from the first there is a large number of these segments, though I cannot determine whether the number is the same as the final number of chromosomes. Perhaps this method of formation of chromosomes without a preceding spireme is to be looked upon as a modification due to a precocious segmentation of the spireme.

In the early prophase of several cleavages, particularly the first division of the first quartette, the chromatin is aggregated into a dense mass at the center of the nucleus, leaving a peripheral zone inside the nuclear membrane which contains no chromatin, text fig. XXIX. Such nuclei resemble in appearance the "synapsis" stages (Moore, Montgomery) of spermatogenesis. This condition is the result of the aggregation of the chromosomes, a phenomenon which occurs in every prophase, while the resemblance to the synapsis is due merely to the persistence of the nuclear membrane for an unusually long time.

c. Separation of Chromosomes and Formation of Daughter Nuclei. The chromosomes, which are at first widely scattered through the nuclear cavity, text figs. XVII and XVIII, are first drawn into the equatorial plate and then transported to the poles of the spindle in the usual manner.

The splitting of the chromosomes in the first cleavage, however, greatly resembles a heterotypic mitosis. In this division many of the chromosomes are shaped like rings, ellipses or triangles, and the parts of these figures lying in the equator grow thinner and thinner, the chromatic substance aggregating in the portions of the chromosomes turned toward the poles, until only a faint linin thread is left completing the otherwise open rings or triangles, fig. 56. I am not sure that this type of division of the chromosomes in the first cleavage occurs in all eggs, since I have found it in only a few cases and have been unable to find it in others of apparently the same stage (cf. figs. 56 and 57).

[1] Montgomery (1900) has rendered these names into the convenient English terms "central pole" and "distal pole," which terms I shall adopt in this paper.

The separation of the chromosomes coincides in point of time with the flow of the interfilar substance of the spindle to the spheres. The chromosomes move toward the poles until they come into contact with the spheres and even spread around them to a certain extent, figs. 59, 66, 67. Such a fact is irreconcilable with the theory that the chromosomes are moved solely by the contraction of the spindle fibres, as Wilson ('95) and Griffin ('99) have pointed out, and suggests that the movements of both interfilar substance and of chromosomes may be due to the chemotropic attraction of spheres and centrosomes, as Strasburger ('93) maintains.

When the chromosomes have reached the borders of the sphere at the end of the spindle they do not enter into the sphere but spread somewhat over its surface figs. 59, 66, 67. In this position the chromosomes are rapidly transformed into vesicles, which grow larger and larger. These vesicles then fuse together and the nucleus becomes an apparently single vesicle, though divided by a partition wall as described above (p. 34). A reticulum of chromatin is then formed within the daughter nuclei, which probably arises from the walls of the chromosomal vesicles, and on each side of the partition wall there appears a single nucleolus, fig. 60. While these chromosomal vesicles are in contact with the sphere, the latter frequently becomes pear-shaped with the pointed extremity toward the chromosomes, fig. 67. In all cases the daughter nuclei have processes which extend partially around and even into the spheres, figs. 60, 81. Gradually, however, the processes disappear as the daughter nuclei increase in size and the latter finally become rounded on the side next the spheres, figs. 61 and 68. The significance of these processes of the nucleus which project into the spheres is not far to seek. The daughter nuclei are at this stage increasing their achromatic substance at a great rate, and the form of these nuclei at once suggests that this substance is absorbed in large part from the spheres. The nuclei of the growing egg cells of *Dytiscus*, as described by Korschelt ('89), are similar in form, and perhaps in function, to this stage of these cleavage nuclei.

Lillie ('99) has observed that just before the "inner sphere" begins to expand, after the second maturation division in *Unio*, it is three-quarters surrounded by the chromosomes, and he suggests that there may be at this time a diffusion of chromatin into the sphere, the interior of which stains more darkly than before. According to my interpretation of the similar phenomenon in *Crepidula*, the chromosomes are at this time absorbing substances from the spheres; not until much later does the "inner sphere" or centrosome again stain more deeply.

During this rapid growth of the daughter nuclei the spheres decrease somewhat in size (cf. figs. 60 and 61, also 67 and 68), in spite of the fact that at this time sphere substance is collecting into the spheres from the astral radiations so that the decrease in the size of the spheres is not so great as it would otherwise be.

The chromatin reticulum which is formed in the daughter nuclei gives place in the next prophase to chromatic granules connected together by linin threads, figs. 61, 62, 70.

In early stages of the prophase, when the centrosomes are just moving into

position at the poles of the nuclei, the latter frequently put out one or more short blunt processes, text figs. VII, VIII, XII. These processes contain chromatin and sometimes dark masses which look like nucleoli. Unlike the nuclear processes of the anaphase, described above, these are usually found on the side of the nucleus away from the centrosome and nearest the mid-body. It is probable that they are withdrawn into the nucleus before the nuclear membrane is dissolved. Their significance is unknown.

This completes the account of the cycle of changes which the nucleus undergoes from one prophase of the cleavage to the next. With the exception of certain minor details, as has been pointed out, each cleavage is like every other in the matter of these nuclear changes. Apart from the equal division and distribution of the chromosomes in each mitosis, the most obvious and striking fact in this nuclear cycle is the escape of so large a part of the nuclear constituents into the cell body during mitosis and the reabsorption of a part of these by the daughter nuclei.

2. Centrosomes and Central Spindles.—*a. Centrosomes.*—The origin of the centrosomes for the first cleavage has already been described in detail (pp. 25–30). These centrosomes are at first minute granules, quite independent of each other. A few fibres are inserted in them and radiate for a short distance into the cytoplasm. Some of these fibres grow toward the nucleus and form a cone or half spindle (figs. 48, 53), while others grow between the two centrosomes and unite them, thus forming a "central spindle" in the manner observed by Hermann ('91), Drüner ('94) and MacFarland ('97). From the time the central spindle appears, the history of the centrosomes of the first cleavage is almost identically like that in the other cleavages so that the following description, unless otherwise specified, applies to any and all of the cleavages.

The minute centrosomes of the prophase (figs. 52, 53, 54, 63, 70, text fig. IV, *a* and *b*) become much larger in the metaphase (figs. 57, 65, 72, 76, text fig. IV, *c* and *d*) and stain less deeply at the center. In the anaphase (figs. 58, 59, 66) the centrosomes continue to enlarge, the periphery alone staining with haematoxylin while the central area takes the plasma stain. Finally in the late anaphase and in the telophase the centrosomes become relatively enormous spheres (figs. 60, 67, 73, text fig. IV, *e* and *f*), frequently 6 to 8 μ in diameter. The peripheral layer or centrosomal membrane grows thinner and thinner until it reaches such a degree of tenuity as to be scarcely visible, ultimately breaking up into granules (figs. 68, 69, 73, 74). In all these respects the metamorphoses of the centrosomes throughout the cleavage are the same as in the maturation divisions.

The central area of the enlarged centrosome is at first apparently homogeneous (figs. 58, 66), but gradually minute granules begin to appear within it and then extremely delicate threads connecting them into a reticulum (figs. 59, 60, 66, 67, 73, text fig. IV). Sometimes one sees, as in figs. 60, 61, 62, one or two granules within the centrosome which are slightly larger than the others; but during the telophase all of these granules are extremely minute and stain very faintly with plasma stains. Gradually they grow larger until they fill the entire centrosome and

their affinity for nuclear stains increases until in the resting stage of certain cleavage cells, these centrosomes look like small nuclei filled with a mass of minute chromatin granules, figs. 61, 69, 76, text fig. IV, *f.* In other cleavage cells these centrosomes with their contained granules remain much less conspicuous. Of all the early cleavage they are most plainly visible in the macromeres just before the formation of the first and second quartettes, figs. 69, 74, 75. The cause of this difference in the appearance of the centrosomes in different cells depends largely upon their size and affinity for stains. The size of the centrosome is always proportional to that of the cell in which it lies; its affinity for stains, during the resting period, increases as it approaches the free surface of the cell, so that although it may stain faintly when a short distance from the surface (figs. 61, 62, 68) it stains deeply when in contact with it (figs. 69, 74). Upon these two factors then depends the relative conspicuousness of the centrosome during the resting period.

In all the cleavages which I have studied, with the exception of the first, the new centrosomes, and probably also the central spindles, arise within the mother centrosome, as in the case of the second maturation spindle. The origin of centrosomes for the second cleavage is shown in figs. 62 and 63, though the origin of the central spindle could not be clearly made out in this case. The origin of centrosomes and spindles for the third cleavage is shown in fig. 70, while those for later cleavages are shown in figs. 74, 75 and 76. In all these cases the centrosomes appear as slightly enlarged granules within the old centrosome. These granules stand at some distance from each other, and in no case in the cleavage have I seen the division of a single granule to form these two; they are, however, connected by the reticulum of threads and granules which fills the mother centrosome, and when the time arrives for the formation of a new mitotic figure the mother centrosome elongates, becoming slightly elliptical in outline, the daughter centrosomes, as two enlarged granules, lie at the extremities of this ellipse, and the reticulum which fills the mother centrosome is drawn out into an irregular spindle shaped body composed of threads and granules, figs. 70, 74, 75, text fig. IV, *g*, *h*, *i*. This elongation continues and the spindle shaped body becomes the central spindle (fig. 76), which in this case consists, not of straight fibres running from pole to pole, but of irregular and anastomosing fibres with granules at their nodes. The daughter centrosomes soon become surrounded by a little area free from granules, which is due to a halo of radiating fibres, so fine that few of them can be seen at this stage. This is the first appearance of the sphere ("couche corticale") and it also arises, at least in certain cleavages, within the mother centrosome, figs. 70 and 76, the membrane of which may still persist at this stage.

At a slightly later stage these radiating fibres become very evident, and with the formation of the cones or half spindles, as described at the beginning of this account of the centrosome, we have the completion of the cycle of changes undergone by the centrosome from one prophase to the next. In a word, the most important features of this cycle are (1) the great increase in size of the centrosome and its transformation into a sphere filled with a reticulum of fibres and granules, and

(2) the origin of the new centrosomes and central spindle from this reticulum; in some cases at least the cortical zone also arises within the old centrosome, so that the entire initial spindle of one cell generation arises within the centrosome of the preceding generation.

b. Central Spindles. In the case of the first cleavage the central spindle is formed after the centrosomes have taken their definitive positions at the poles of the germ nuclei, figs. 55 and 56. It first appears as a few fibres running from centrosome to centrosome in the line of contact between the egg and sperm nuclei. These fibres run independently from pole to pole and do not branch and show cross anastomoses with one another, so far as I have been able to observe; there are no varicosities or granules on them, as is the case in the later cleavages. The central spindles for the second cleavage are shown in surface view in fig. 82 and text fig. VIII, running from centrosome to centrosome over the surface of the nuclei and in the groove between the nuclear halves. In a section of a somewhat earlier stage (fig. 63), I have been unable to detect the fibres of the central spindle, though there is a clear area free from granules lying immediately over the nucleus and between the centrosomes in the position of the central spindle.

In the later cleavages the origin of the central spindle within the mother centrosomes can be plainly observed figs. 70, 74, 75, 76. The central spindle is in these cases a long drawn out reticulum with granules at its nodes. These granules gradually disappear as the spindle elongates and their substance is evidently transformed into the central spindle fibres.

In *Crepidula*, then, there appear to be two methods of origin of the central spindle: in the first cleavage the spindle arises in the cytoplasm between two independent centrosomes; in all the other cleavages the centrosomes and central spindle arises as a unit structure within the mother centrosome; in the former case the fibres arise *de novo* between the centrosomes, in the later they arise as a centrodesmus (second maturation) or from the centrosomal reticulum (later cleavages).

3. Polar Rays and Spindle Fibres.—When first visible the polar rays are extremely short and delicate fibres and their presence is to be recognized rather by the clear area ("cortical zone") surrounding the centrosome than by the recognition of individual fibres, figs. 70, 76. Soon these fibres become larger and longer and are plainly visible, figs. 52, 53, 63. Those directed toward the nucleus become stouter and more numerous than the others, and the nuclear membrane is frequently indented where they come into contact with it, figs. 53, 54, 71. In some cases, however, the nuclear membrane is not indented, but is drawn out into a cone, the apex of which lies near the centrosome. Whether the membrane is invaginated or evaginated, there is in both cases an escape of achromatic nuclear substance at the poles, and it is due to this substance that the extra-nuclear fibres grow stouter and become covered with oxychromatin granules, text figs. XVII–XIX. In the first maturation division, not only the fibres of the extra-nuclear spindle, but also all the polar fibres are studded with these granules; in the cleavage, however, I have not observed them on the polar fibres. In early

prophases the fibres of the extra-nuclear spindles are directly continuous with the linin threads of the nucleus, which they closely resemble in every respect, text figs. XVII and XVIII. Like the linin they branch and anastomose and are studded with oxychromatin granules. This resemblance is so striking that I cannot doubt that the fibres of the extra-nuclear spindles are really derived from the achromatic substance of the nucleus.

As in the maturation, so also in the cleavage there is an interfilar substance which fills the spaces between the fibres and which constitutes the greater part of the bulk of the amphiaster. This interfilar substance is probably derived in part from the hyaloplasm of the cell body and in part from nuclear sap containing dissolved oxychromatin.

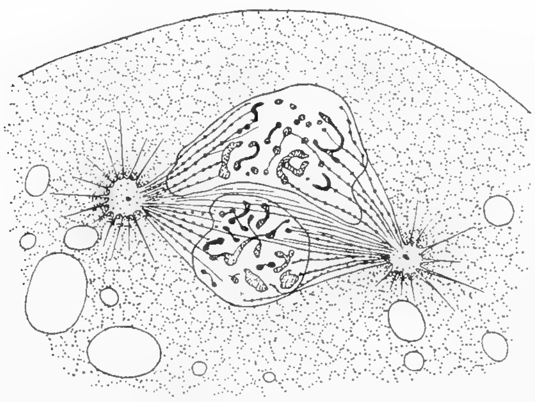

Fig. XVII.—Prophase of first cleavage of *Crepidula*.

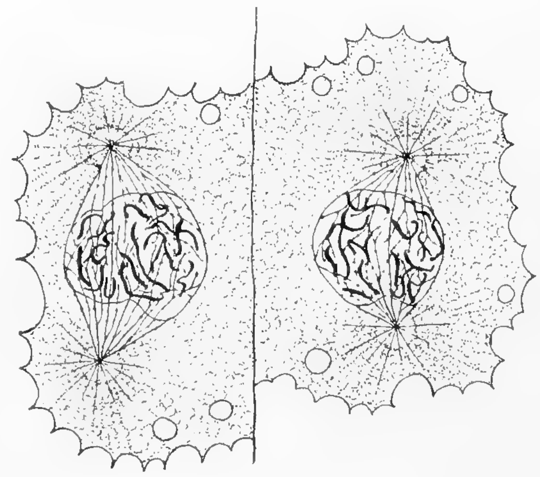

Fig. XVIII.—Prophase of second cleavage of *Crepidula*.

Throughout the metaphase the spindle-fibres are to a great extent concealed by this interfilar substance which fills in the whole space between them. In strongly destained specimens, however, the fibres can always be seen in the spindle. After the metaphase, however, no fibres can be seen crossing the dark zone which now surrounds the centrosome; both polar fibres and spindle-fibres appear to stop at the boundary of this cortical zone, or rather sphere. In the anaphase the structure of the sphere is such that one may be quite sure that neither polar nor spindle-fibres run through it, figs. 58, 59, 60, 66, 67, 68. In both metaphase and anaphase the polar fibres are not always centered on the centrosome, and if they were continued in a straight line through the sphere some of them would not touch the centrosome at all, figs. 57, 58, 60, 65, 67.

Just before the chromosomes reach the boundary of the spheres the mitotic figure is cylindrical in shape and consists almost entirely of interzonal filaments, figs. 58, 66. As soon as the chromosomes have reached the spheres and are transformed into vesicles, figs. 59, 67, the spindle again becomes wider in the middle than at the ends and contains many fibres which do not reach from pole to pole.

The spindle greatly increases in length from the prophase to the telophase. R. Hertwig ('99) has observed that in *Actinosphærium* the spindle more than doubles in length during this period, and in *Crepidula* the lengthening is nearly as great. The shape of the spindle varies greatly from prophase to telophase, being largest at the equator in the prophase and smallest in the telophase.

Mid-body.—When the new cell-wall is formed the spindle is constricted in the middle and a very remarkable mid-body (*Zwischenkörper*) is formed. This mid-body is elliptical in outline, and is surrounded by a dark area from which radiations proceed in all directions; into this dark area the cell-membrane and the two halves of the spindle enter, fig. 60. This mid-body is for all the world like a centrosome with its surrounding sphere and aster, and recalls Watase's ('93) comparison of the mid-body to an intercellular centrosome. This apparent resemblance is still further supported by the fact that the mid-body in this case becomes a hollow sphere before it finally disappears, fig. 61, just as the centrosome does.

The mid-body is surrounded by a darkly staining substance which resembles the sphere substance. This recalls Moore's ('93) observations on the larval Salamander, where he finds a mass of archoplasm on each side of the mid-body, also Kostanecki's ('92) statement that the mid-body is formed from granules of the sphere (archoplasm). Kostanecki ('97) has observed a mid-body in *Physa* consisting of a ring around the central spindle-fibres, from which radiations proceed. In some cases this ring divides through the middle into two rings. A similar ring is called by Heidenhain "*Zellnabel*." Moore and Meves have seen mid-bodies connected with the centrosomes around the nucleus, as is plainly the case in the third cleavage of *Crepidula* (see fig. 73).

The cell-membrane adjoining the mid-body is thicker and more protoplasmic than at the periphery, and is in process of formation at this place. The mid-body persists through the whole of the resting period and until the prophase of the next succeeding division when it gradually disappears. As long as it is present there can be no doubt as to protoplasmic continuity between the daughter cells.

4. Spheres.—Before the nuclear membrane is indented, the centrosomes are surrounded by a clear area consisting of a halo of radiating fibres, figs. 63, 70, 76. This condition may exist even within the mother centrosome (see fig. 70). This clear area is the first appearance of what I shall call the sphere ("outer sphere" of Lillie, "couche corticale" of Van der Stricht). When the nuclear membrane is dissolved at the poles substances escape from the nucleus into this area surrounding the centrosomes. At the same time hyaloplasm from the cell body is probably drawn in through the astral rays into the same area. There is thus a commingling of hyaloplasm and chromatic nuclear sap which constitutes the interfilar substance of the aster. There is at this stage no clearly marked sphere, since the central area of the aster is in no way delimited from the surrounding radiations.

In middle stages of mitosis it is difficult, even in thoroughly destained specimens, to trace the polar rays and spindle-fibres through the interfilar substance to the centrosome. In the anaphase the interfilar substance of spindle and aster

collects into the central area surrounding the centrosomes, and this area, thus delimited from the surrounding plasm, is the sphere; at the same time the spindle-fibres again become plainly visible while a reticular or alveolar structure appears within the spheres, fig. 58.

In the late anaphase the spheres become much larger and are bounded by a layer of microsomes from which fibers radiate. The interior of the spheres is composed of a fine reticulum with nodal thickenings, and the whole sphere stains much less densely than in earlier stages. Finally in the telophase the spheres reach their greatest size and become filled with granules, the reticulum being scarcely visible, or disappearing altogether (figs. 61, 68, 73).

During the whole of the resting period the spheres persist, usually pressed close to the cell-membrane, and as long as the centrosomes remain in them they preserve a regular form (figs. 68, 69, 73, 74, 76). They are composed of coarse granules, which stain deeply with plasma stains, and they are sharply bounded by one or more layers of microsomes. As soon as the daughter centrosomes and central spindle arise from the mother centrosome, they migrate out of the sphere and the latter at once begins to lose its regular form. It becomes ragged in outline and is finally flattened out to a thin layer of densely staining granules immediately under the cell-membrane (figs. 63, 65, 70, 71, 72, 73, 74, 76).[1]

These granules, the remains of former spheres, can frequently be recognized through two generations of cleavage cells; *e. g.*, the spheres which appear in the second cleavage (figs. 68–72) can still be recognized after the completion of the third cleavage, located in the first quartette of micromeres (figs. 73 and 74, see also figures of entire eggs in Plates V and VI). From the time when the daughter centrosomes issue from the spheres the latter are degenerating structures, and although their remains may persist for a surprisingly long time they ultimately disintegrate and are apparently dissolved in the cytoplasm.

To sum up the history of the spheres: we find that they arise around the centrosomes at a very early period in the mitosis, in some cases within the mother centrosome. With the disappearance of the nuclear membrane at the poles of the spindle they are invaded by an interfilar substance; they have no clearly marked boundary. In the anaphase and telophase the spheres greatly enlarge, but their growth is always proportional to the size of the cell in which they are found. They are largest in the anaphase just before the chromosomal vesicles begin to form and they probably contribute to the growth of the daughter nuclei. At first they have a delicate radiating structure, this gives place to a homogeneous condition, and this to an alveolar or reticular one; finally, in the rest stage they are granular. Their fragments persist long after the daughter centrosomes have moved out of them, and they ultimately dissolve and disappear in the cytoplasm.

[1] In surface views of entire eggs the sphere may seem larger in the resting stage or early prophase than in the telophase, *e. g.*, figs. 81 and 82, 86 and 87, etc.; this is due, as sections show, to a flattening of the sphere against the cell-membrane and a spreading of the sphere substance through the influence of the astral rays, and not to an actual increase in its volume (figs. 71, 72, 76).

IV. General Considerations and Comparisons.

I propose to give in this section a brief synopsis of the changes which the nucleus, centrosome and sphere undergo during the whole cycle of division in the mollusks which I have studied; to compare these observations with closely related ones in other animals and to indicate the general conclusions to which these observations lead.

1. The Nucleus during the Cycle of Division.—The history of the nuclear changes during the cycle of division may be summarized as follows: (1) The chromosomes, consisting of chromatin inclosed in a linin sheath, divide and move to the poles of the spindle where they partially surround the spheres. (2) Here they become vesicular, the interior of the vesicle becoming achromatic, though frequently containing a nucleolus-like body, while the wall remains chromatic. (3) These vesicles continue to enlarge and then unite into the "resting nucleus"; the nuclear membrane is composed of the outermost walls of the vesicles, while the inner walls stretch through the nucleus as chromatic partitions; the chromosomal vesicles from the egg and sperm nuclei remain distinct longer than those from the same nucleus. (4) The chromatin of these inner alveolar walls then aggregates into threads, giving rise to a "chromatic reticulum," though the linin still preserves, for a time at least, the alveolar structure. (5) The chromatin of these threads then aggregates into spherules, which are connected together by linin threads; these spherules vary in size, and at first all are solid and stain alike. (6) They then become hollow and are differentiated into oxy- and basi-chromatin. (7) In the first maturation each of the basichromatin spherules, or bodies, grows into an individual chromosome; in the cleavage the basichromatin spherules unite into several linear series, thus forming a segmented spireme. (8) The oxychromatin spherules grow smaller and some are dissolved in the nuclear sap while others are arranged in series on the linin threads into which they are transformed; these threads with attached spherules form the spindle fibres. (9) During the differentiation of the chromatin the nucleus swells in size and the membrane becomes less chromatic, while the nuclear sap becomes more so; the nuclear membrane then dissolves at points opposite the centrosomes and linin, oxychromatin and nuclear sap here escape. (10) The spindle, which at first fills the entire nuclear cavity, then grows longer and slenderer and contains an interfilar substance; the nuclear membrane entirely disappears; the equatorial plate stage is then reached and the cycle is complete. In a word, the daughter chromosomes absorb achromatic substances, and unite to form the nucleus, within which the chromosomes and spindle of the next division arise, while nuclear sap and dissolved chromatin escape into the aster and cell body.

Taking up now in more detail some of the individual steps in this cycle:

(*a*) *Formation of Chromosomal Vesicles.—Growth of Daughter Nuclei.*—When the chromosomes have reached the ends of the spindle, and in some abnormal cases even before this (see text fig. IX), they begin to absorb achromatic material and to swell into spherical vesicles. Such vesicles are found generally, if not uni-

versally, in the early divisions of ova, though they are not usually found in other mitoses. What is the cause of this difference? It occurs to me that it may be due to differences in the size and in the rapidity of division of blastomeres as compared with tissue cells.[1] The following observations favor this view: — The chromosomal vesicles are proportional in size to the size of the cell (quantity of cytoplasm) in which they lie. The daughter chromosomes which go to the two poles of the spindle are always equal in size however unequal the cell division may be, until the time when the daughter cells are separated by the new cell wall. Immediately after this separation a difference appears in the size of the vesicles in the two cells, if the division was unequal, the larger cell containing large chromosomal vesicles while in the smaller cell they remain small or do not show the vesicular structure at all.

The chromosomes which go into the polar bodies do not appear vesicular at any stage, though after the division of the first polar body they fuse into a single nucleus in each cell which contains very little achromatic material. The smallest cells in the early stages of cleavage are the "trochoblasts" (fig. 97, $1a^2$–$1d^2$); these cells do not again divide for a very long period, and in them the chromosomal vesicles are at first very small. Chromosomal vesicles appear in the anaphase of all the other cleavages, but as the cleavage advances and the blastomeres grow smaller these vesicles become less and less apparent.

From these observations I conclude that in large cells where divisions succeed one another at short intervals the chromosomes begin the growth characteristic of the daughter nuclei, *i.e.*, the absorption of substances from the cell body, before they have fused together, whereas in small cells or cells which divide only at long intervals the chromosomes fuse before the absorption of achromatic material begins.

After the fusion of the chromosomal vesicles to form the daughter nuclei, the latter continue to absorb achromatic material, growing larger and larger, until the prophase of the next division. A part at least of the achromatic material absorbed is derived from the sphere which in turn contains interfilar substance of the spindle and aster. This recalls the conclusions of O. Hertwig ('75), in which he points out that in the formation of the daughter nucleus the chromosomes absorb "*Kernsaft*" and become vesicular, the process being the reverse of what occurs in the beginning of division, when "*Kernsaft*" is set free into the cell body. A similar view was held by Bütschli ('76).

In the growth of the nucleus the nuclear membrane has the properties of a semi-permiable membrane, *i.e.*, substances pass readily through the membrane in one direction, but not in the other. Reinke (1900) has suggested that the nuclear ground substance is a diosmotic material, which, by taking up substances from the cell, produces a substance of higher osmotic pressure. When, on the other hand, the nuclear membrane dissolves and the ground substance of the nucleus mingles with the fluid substance of the cell, the peripheral layer of the latter assumes the

[1] Flemming ('92) formerly held that all chromosomal vesicles were artifacts. Now that they have been found, however, in so large a number of ova, prepared by the best modern methods, such an idea cannot be maintained.

role of a semi-permeable membrane and thereby the swelling of the dividing cell is produced which Reinke calls "mitotic pressure." The manner of growth of the nucleus, its turgescence and the infolding of its membrane in the prophase preclude the idea that the nuclear membrane is full of pores as held by Carnoy, Watase, and formerly by Reinke, and indicate that the growth of the nucleus is a phenomenon of diosmosis.

However unequal the division of the cell body may be the daughter nuclei are at first entirely equal, but the subsequent growth of the nucleus is proportional to the quantity of cytoplasm in which it lies; this is shown not only in the cleavage of the egg, but also in the formation of the polar bodies. The nuclei of the polar bodies rarely become vesicular but remain chromatic throughout. The fact that the size of the nucleus is proportional to the quantity of the cytoplasm in which it lies indicates that the achromatic substance absorbed by the nucleus is also proportional in quantity to the volume of the cytoplasm.

It sometimes happens, especially in eggs in which more than the normal number of centrosomes and asters are present, that some or all of the chromosomal vesicles do not fuse, but remain distinct through the whole of the resting period. In such cases each of the vesicles behaves like a miniature nucleus, absorbing achromatic material and forming a network of chromatin either within the vesicle or on its walls, In this growth and differentiation the vesicles keep pace, step by step, with the normal nucleus, so that one must regard the resting nucleus as virtually composed of vesicles, though their union may be so intimate as to hide this structure. The resting nucleus is not, therefore, a single structure any more than is the equatorial plate. It is composed of units, each of which, so far as known, has the properties of the entire nucleus, and the union of these vesicles into a single one may be considered as a secondary character. It is altogether probable that the chromosomes, and hence the chromosomal vesicles, preserve their identity throughout the resting period, and I venture the suggestion that the daughter chromosomes will be found to arise within the chromosomal vesicles, as the daughter centrosomes, or centrioles, arise within the mother structures.

(*b*) *Chromatic Differentiation; Solution of Oxychromatin and Nuclear Membrane.*—In the early prophase of each division in the mollusks which I have studied, the chromatin becomes sharply differentiated into oxy- and basi-chromatin (Heidenhain). This differentiation occurs before the solution of the nuclear membrane, but at a time when the nucleus is growing rapidly in size and is therefore actively absorbing substances from without. This suggests that the rapid absorption of cell substance and the differentiation of the chromatin are associated, but whether this absorption is the cause or the result of the chromatic differentiation, I am unable to determine.

The solution of the nucleoli usually precedes that of the oxychromatin spherules and the nuclear membrane, but in the case of the first maturation the enormous nucleolus is thrown out into the cytoplasm before it is completely dissolved. Many oxychromatin granules are not dissolved in the nuclear sap,

but contribute directly to the formation of the linin threads and spindle fibres, as Wilson ('95) and Griffin ('99) have found to be the case in *Toxopneustes* and in *Thalassema*. This is especially the case in all small nuclei, whereas the larger the nucleus the greater the quantity of oxychromatin which dissolves and passes into the cytoplasm.

The solution of the nuclear membrane goes on coincidently with the solution of the oxychromatin, so that it seems probable that the causes of the two are the same. Before its solution the membrane changes its staining qualities, becoming more and more plasmatic in reaction. The membrane is in all cases first dissolved at points opposite the centrosomes. In this process the membrane undergoes one of two modifications: either (1) it is drawn out toward the centrosomes into a cone-like figure, or (2) it is indented opposite the centrosomes. Both of these methods may coexist in the same animal, though one or the other is usually predominant. Among mollusks of all classes, the membrane is usually indented. The difference between these two methods is not great, depending upon the time at which the membrane is dissolved and upon the rate of outflow of nuclear substance; if the membrane is thin and dissolves early a cone is formed; if it dissolves slowly and only after a considerable quantity of nuclear substance has escaped, it becomes indented. The strength of the nuclear membrane in *Crepidula* is shown not only by the degree of indentation which it suffers before it is completely dissolved at the poles, but also by its long persistence in the equator of the nucleus (see figs. 84 and 88). Even when the membrane persists for a long time and becomes deeply indented at the poles it need not be supposed that pressure is brought to bear by the polar fibres or by other means upon the membrane; on the contrary, the indentation is chiefly or entirely due to the escape of nuclear sap and the consequent collapse of the nuclear wall.

The infolding or outfolding of the nuclear membrane at points opposite the centrosomes is a very common phenomenon among all classes of animals. It would be useless to attempt to summarize all the observations on this point, and I shall refer to only two recent works which touch upon this subject:—

Montgomery ('98) has observed a cone-shaped protrusion of the nuclear membrane opposite each centrosome in *Pentatoma*. These cones contain a dark substance which he believes to be of nucleolar origin.

Fischer ('99) interprets the openings at the poles of the nucleus as due to a greater growth of the nucleus at these points. The fact, however, that it first occurs opposite the centrosomes and in connection with the formation of the half spindles, indicates that the opening in the nuclear membrane is due rather to the solvent action of some substance which diffuses to or from the centrosomes.

(*c*) *Escape of Nuclear Substances; Aster and Spindle Formation.*—It may be considered certain that the infolding (or outfolding) of the nuclear membrane at points opposite the centrosomes is due to an outflow of nuclear substance at these points. This is conclusively shown by the fact that the linin reticulum, with its attached chromatin granules, here extends outside the nuclear wall nearly to the

centrosome and forms the extra-nuclear portion of the spindle. The aster also stains more deeply after this outflow than before and very like the chromatic nuclear sap.

The shape of the spindle depends in part upon the degree and stage of this nuclear outflow. The spindle is at first as wide at the equator as the entire mother nucleus, but as the flow of nuclear substance toward the poles continues it grows longer and slenderer, the centrosomes at the same time moving farther and farther apart, until in the late anaphase almost the whole of the interfilar substance has moved out of the spindles into the spheres.

Whether or not the spindle fibres and linin threads exist as such in the living cell or are artefacts must still be left an open question. It can scarcely be doubted, however, that they do represent substances which are different from the surrounding materials of the cell, and this is after all the important thing. That the spindle-fibres and especially the connective fibres sometimes show considerable elasticity and rigidity has been pointed out repeatedly by those who hold that the centrosomes are pushed apart by their activity. Nowhere is this better shown than in the first maturation of *Crepidula*, where in the shortening of the spindle the fibres are bent and kinked and the chromosomes at the outer pole are pushed clear through the polar body into contact with the opposite cell wall. In spite of this, however, it seems to me very questionable whether the spindle fibres are anything other than a fluid more viscid than the surrounding cell substance.

I agree with those authors (Bütschli, Fischer, Rhumbler, Wilson), who hold that the astral rays represent diffusion streams in the cytoplasm, rather than a stable system of fibres. There are certain evidences that the astral rays are composed in the main of cytoplasmic material, principally hyaloplasm or interalveolar substance; chief among these is the fact that the aster is always proportional in size to the extent of the cytoplasmic area which comes within its influence, a fact which Wilson ('96) emphasized and which I also ('94) pointed out and have since had abundant opportunity to verify. But while the aster and astral rays are in the main composed of hyaloplasm it is probable that in normal mitoses certain nuclear substances enter into their formation. In the mollusks which I have studied there can be no doubt that certain achromatic substances from the nucleus and spindle flow into the aster and at the same time the central area of the aster as well as its rays stain more deeply than the hyaloplasm throughout the cell body. Whether there may not be a centrifugal movement of escaped nuclear substance along the astral rays as well as a centripetal movement of the hyaloplasm must be left an open question.

In this connection I must refer to one of the first observations ever made on indirect nuclear division,—that of Auerbach ('74) on the living eggs of certain nematodes. He observed the double suns (asters) with their connecting stalk (spindle) and supposed that they were formed by the collapse of the nucleus and the passing out of nuclear sap into the cytoplasm, "the astral radiations being merely the expression of the paths along which fine streams of nuclear sap pass out into the protoplasm." Bütschli ('76) also observed the passage of nuclear sap

into the cytoplasm during nuclear division; in *Cucullanus* and *Nephelis* this loss of nuclear fluid may amount to as much as two-thirds of the volume of the unaltered nucleus. Bütschli held that this fluid escaped at the two poles of the nucleus and accumulated in the central areas (asters), from which it radiated into the cell body. Further Bütschli observed that the more a daughter nucleus grows, the more the central area of the neighboring radial system diminishes, whence he inferred that the latter furnishes material for the growth of the former. (See Mark, '81, p. 321.)

In 1892 Bütschli reversed his former view as to aster formation, holding that it is due to a flowing of plasma into the spheres or centrosomes and not from them. He supposed that the centrosomes attracted substances dissolved in the enchylemma as a hygroscopic substance attracts water, and that the diffusion movements thus produced cause the astral radiations. Although Bütschli in his 1892 work, and since in 1898 and 1900, maintains that the astral radiations are due to an attraction exerted by the centrosome, he expressly stated in the first mentioned work that it is unimportant whether the diffusion streams move in one direction or the other (*i. e.*, centrifugally or centripetally).

I fully agree with Bütschli that the astral rays are the expression of diffusion streams. In the process of diffusion the commingling substances may move in opposite directions at the same time, and it is quite possible that the balance of flow between the centripetal and the centrifugal diffusion movements may lead to a centrifugal flow at one time and to a centripetal flow at another.

Rhumbler ('96, '99) has also developed an elaborate theory of aster and spindle formation which is based in the main upon this view of Bütschli's. He holds that the astral rays are reducible to tension on the alveolar radii; this tension being due to the fact that the centrosomes, and later the nucleus, take up fluids from the surrounding plasm. He also holds that the two spheres exert a pull on the nucleus which leads to the formation of the spindle and to the escape of nuclear sap into the equatorial plane of the cell, where the division wall will form.

I accept Rhumbler's views as to the flow of cell and nuclear substances toward the centrosome, but cannot agree with him that the nuclear sap escapes largely or entirely in the equatorial plane. Much of the nuclear sap as well as the oxychromatin and linin escapes at the poles of the nucleus and, although nuclear contents escape into the cytoplasm in all directions when the nuclear membrane is completely dissolved, there is no evidence in the cases which I have studied that this has to do with the formation of the division wall.

Fischer ('99) holds that the spheres of animal eggs are to be explained as substances escaped from the nucleus, and he suggests that the astral rays may be normally formed by the diffusion of substances from the nucleus into the cytoplasm and the production there of non-soluble substances. He considers that such radiations are not persistent structures, but that they may appear and disappear repeatedly during the course of a single division. I agree with Fischer that there is an escape of nuclear substance at the poles of the nuclei, and that the astral rays

represent diffusion streams through the cell body, but I am not sure that I understand him when he says that the rays are composed of non-soluble substance, since they certainly disappear (as he also maintains) either by dissolving in the cytoplasm or by being absorbed into the sphere.

Meves ('99) criticises Fischer's views on aster formation by saying that such rays as Fischer describes could not grow interstitially, as normal rays and spindle fibres are known to do; sometimes also extensive rays appear in the anaphase, long after the mingling of nuclear and cytoplasmic substances. If, however, these rays be considered as diffusion streams to or from the centrosome, in the sense of Bütschli, these criticisms lose most, if not all, of their force. Finally, that the astral rays are not fixed structures stretching between the centrosome and the cell membrane, as Heidenhain and Kostanecki hold, is shown by the fact that in many mitoses the spindle is free to turn and move through the cell, and yet the astral rays show neither twisting, bending, nor distortion. This is shown especially well in the first maturation, and in the first three cleavages of *Crepidula*, where there are considerable movements of the amphiaster even after the metaphase; but in no case is there a corresponding bending of the rays, as there would be if these were fixed structures (see observations of Ziegler, Lillie, *et al.*, Part II, Sec. III).

(*d*). *Chromatic Elimination.*—In the maturation and early cleavages of the eggs which I have studied, the total amount of chromatin which is transformed into linin or dissolves and escapes into the cell body is greater than that which goes to form the chromosomes; the amount of cytoplasm in the cell is also noticibly greater after the nuclear membrane is dissolved than before.

In this connection other observations of a somewhat similar character may be recalled. Almost all persons who have studied the maturation of the egg, have commented upon the large quantity of nuclear material which is set free into the cell body during the first maturation division. In the starfish, according to Wilson ('95, p. 458), at least nine-tenths of the chromatin is thus set free. Gardiner ('98, p. 97) estimates that in the egg of *Polychœrus* not more than one five-hundreth part of the chromatin which is present in the germinal vesicle goes into the chromosomes, all the rest being thrown out into the cell. Most observers agree in identifying as chromatin this nuclear material which escapes into the cell body, though in most cases it stains less deeply than the chromosomes and its subsequent dissolving shows that it must be different from the chromosomes, which never dissolve. Gardiner ('98, p. 98) argues that there must be two kinds of chromatin, the one soluble, the other not, and Griffin ('99) believes that the soluble chromatin arises as a nuclear reticulum which at first takes plasma stains and later nuclear ones.

Boveri's ('92 and '99) observations on the diminution of the chromosomes in the somatic cells of *Ascaris* may be recalled in this connection. In this case the ends of the chromosomes pass into the cytoplasm during the mitosis and there gradually undergo solution or disintegration. This case, however, differs greatly from that of *Crepidula* since it occurs only in differentiation of somatic cells, whereas in *Crepidula* the outflow of nuclear material occurs at each and every

mitosis. Häcker ('97) has described an elimination of nuclear constituents in the *Keimbahn* of *Cyclops;* in the first cleavage a large number of granules ("ektosomes"), which Häcker considers escaped nucleoli, collect around one attraction sphere but not around the other. This process is repeated in subsequent cleavages, the cells in which the ektosomes appear marking out the *Keimbahn*. Finally, in the division of the genital cells the ektosomes are found around the entire spindle figure. The elimination of the ektosomes in *Cyclops*, like the diminution of the chromosomes in *Ascaris*, differs fundamentally from the chromatic elimination in *Crepidula*, in that the latter occurs in all the cleavages irrespective of whether the blastomeres are progenitors of the germ cells or not.

In the ovarian eggs of many animals an elimination of nuclear constituents has been observed (for a list of these cases see Meves, '94, p. 149); all these cases deal with elimination during the resting period of the nucleus. On the other hand my observations mentioned above, as well as those of Wilson ('96, p. 141) on *Nereis*, Mathews ('95) on *Asterias*, Gardiner ('98) on *Polychærus*, Griffin ('99) on *Thalassema*, and many others, show that there is an escape of chromatic substance from the nucleus into the cytoplasm during the period of mitosis. In the cases just mentioned this elimination occurs during the first maturation division, and Griffin at least, affirms that it does not occur in the cleavage mitosis. In *Crepidula*, on the other hand, it occurs in every mitosis (except that of the second maturation), though it is, of course, most evident where the nucleus is large and the amount of chromatin great.

In this connection the theoretical conclusions of De Vries, Weismann and Roux, concerning the nuclear control of the cell should be recalled. De Vries holds that there is an actual migration of pangenes from the nucleus into the cell body, these pangenes giving character and direction to all cytoplasmic processes, in fact, both De Vries and Weismann assume that the entire cytoplasm is the product of the pangenes. Roux holds that the nuclei become progressively specialized during development, and that these specialized nuclei determine the character of the cytoplasm, but he does not suggest how this determination occurs. Weismann accepts and unites both the views of De Vries and those of Roux.

Judging these theories by the facts of chromatic elimination in *Crepidula* and other gasteropods, I am compelled to conclude that in all nuclei the chromatin appears the same in character, differing only in quantity; in all nuclei the chromatin is differentiated into oxychromatin and basichromatin, the latter alone forming the chromosomes, while the former is eliminated; there is no evidence of progressive differentiation of the nuclei. That these facts, however, are not conclusive against the theory of Roux is shown by the fact that in *Ascaris* there is a specialization of the somatic cells as distinguished from the germ cells; if such a specialization occurs in *Crepidula* it must begin at a much later period than in *Ascaris*. On the other hand, the fact that the eliminated chromatin is differentially distributed to the cleavage cells (see Part II, Sec. II) may be held to afford evidence of the fact that it plays some part in the differentiation of blastomeres.

But whatever the theoretical bearings of this elimination may be, there can be no doubt of the fact that in *Crepidula*, and perhaps in a large number of animals, there is a very extensive exchange of material between the nucleus and cytoplasm, and, further, that a large part of that most characteristic nuclear substance, the chromatin, passes into the cytoplasm in the form of oxychromatin during every cell cycle, while a relatively small portion is preserved for the purpose of reproducing the daughter nuclei.

There is thus in karyokinesis a rhythmical growth and collapse of the nucleus as a whole, the new nuclei arising endogenously, *i. e.*, from chromosomes, within the old. In fact, one might speak of these changes in the nucleus as a systole and diastole (Ryder, '94), by means of which an exchange of nuclear and cytoplasmic material is brought about.

The nuclear membrane appears to permit the passage of materials inward but not outward during the resting period, whereas the escape of nuclear material into the cell is brought about by the disappearance of the nuclear membrane during karyokinesis. Such a process is not universal, for in cells where karyokinesis occurs very rarely, or not at all, the interchange between cytoplasm and nucleus has been observed to take place, but the phenomena described are characteristic of mitosis in general.

2. Centrosomes and Central Spindles.—*a. Structure and Metamorphoses.*—It is evident from the history of the centrosomes of *Crepidula* that throughout the maturation and cleavages up to at least the 60-cell stage, the centrosomes are absolutely continuous from one cell generation to the next, with the possible exception of the fertilization stages. Of this fact there can be no particle of doubt. With the exception of the earliest origin of the centrosomes of the first maturation, and with some reserve as to the origin of the centrosomes of the first cleavage, I believe that I have seen every step in the origin and metamorphoses of the centrosomes up to the 12-cell stage; while in all the cleavages up to the 60-cell stage, or even later, I have observed and drawn the centrosomes at almost every stage in the cell cycle. Fortunately, this is not a very difficult thing to do, since the centrosomes are so large and distinct that even during the height of the resting period they can be seen in entire eggs, and their elongation to form the central spindles plainly observed (see Plates V, VI).

The principal features of the entire centrosomal cycle from one cell division to the next may be summarized in a single sentence: *The minute granules at the poles of the central spindle enlarge until they become hollow spheres within which new centrosomes and central spindles appear.* The individual variations characteristic of the maturation and the different cleavage stages have been mentioned in detail, and need not be reviewed here; it is sufficient to say that the history of every centrosome conforms to the above statement.

From this it is evident that the centrosomes and central spindles form a unit structure, as Heidenhain ('94), MacFarland ('96) and Boveri ('01) maintain. Only in the fertilization is this not the case, and there are few, if any, well authenticated

cases on record in which the centrosomes and central spindle of the first cleavage form a unit structure. Even in many of those cases in which there is a division of the sperm centrosome and a well-marked central spindle between the halves (*e.g.*, *Physa*, *Pleurophylidia*, *Unio*, *Cerebratulus*, *Thalassema*, *Arenicola*), this central spindle completely disappears and the definitive spindle is formed *de novo* between independent centrosomes. In view of the unit structure of centrosomes and central spindles in other divisions, this is certainly a striking phenomenon, and indicates that the centrosomes of the first cleavage are in their first appearance more independent of each other than in any subsequent cleavage. It also suggests a possible way of unifying the conflicting accounts as to the origin of the cleavage centrosomes.

(*b*). *Relation of Centrosome to Cell Body and Sphere.*—In the mollusks which I have studied, the centrosome is at all stages in its cycle sharply delimited from the surrounding cell-body and sphere. The outer zone of the mother centrosome does not disintegrate and lose its outlines until after the daughter centrosomes and spindle have appeared within it, so that in all stages of the cell cycle there is a clearly marked centrosome. In the cleavage the outlines of the centrosome are most difficult to distinguish in the anaphase (figs. 59 and 67), but even at this stage there can be no doubt of its sharp separation from the surrounding sphere. Only in the egg and sperm asters during the approach of the germ nuclei is this separation completely lost. No clearly marked sperm centrosome can be recognized at any stage, and the egg centrosome which is very evident during the anaphase of the second maturation, and which during this period undergoes a typical transformation into a hollow sphere (figs. 32–36), loses its outlines and completely disappears in the surrounding sphere before the union of the germ nuclei. This again marks a peculiarity in the centrosomes during fertilization not found in any other cell cycle.

The centrosomes and spheres grow simultaneously reaching their greatest size in the telophase or resting period when the astral radiations are smallest; the astral radiations again become prominent when the new centrosomes have moved out of the old centrosomes and sphere and are growing rapidly in size. The growth of the centrosomes and spheres is not coincident with that of the nuclei; on the contrary they are smallest when the nuclei are largest, viz., in the early prophase, and they have nearly reached their largest dimensions when the nuclei are smallest, *i. e.*, in the late anaphase before the formation of the chromosomal vesicles (*cf.* figs. 3 and 16, 27 and 34, 53 and 59, 63 and 67). This, as well as other morphological phenomena involved in the escape of achromatin at the poles of the spindle and the coincident growth of the spheres and centrosomes, together with the changes in the staining reactions of the latter, indicates that the spheres and centrosomes grow in part at the expence of substance escaped from the nucleus. That this is not a complete statement of the facts, however, is shown by all cases of unequal cleavage, in which the centrosomes and spheres at the two poles of the spindle are always equal until the constriction of the cell body begins (figs. 15, 33, 72, etc.), but immediately after this they become unequal in size, and in the end are proportional

in size to the quantity of cytoplasm in which they lie (figs. 16, 34, 73, etc.). We have already seen that the nucleus is always proportional in size to the cytoplasm in which it lies, and we are also compelled to conclude that the size of the centrosome and sphere depends ultimately upon the quantity of cytoplasm. This must be taken to indicate that both centrosome and sphere receive substance from the cytoplasm during their period of growth, and on the other hand it can plainly be seen that the remnants of the old centrosomes and spheres are slowly transformed into cytoplasm or cell membrane after the new centers have moved out of them. There is, therefore, an interchange of substance between cytoplasm and centrosome, wholly similar to that between cytoplasm and nucleus (see p. 53).

(*c*). *Relation of Centrosome to Nucleus.*—In certain cleavages the centrosomes, especially during the resting period, are very large and conspicuous, *e. g.*, in the pause preceeding the third and fourth cleavages (figs. 69, 74), they are fully six μ in diameter. They contain a reticulum of material which stains blue or black with hæmatoxylin, and on the whole they present an appearance remarkably like nuclei. In no case, however, have I seen any evidence that the centrosomes are directly derived from the nuclei, though this may possibly be the case in the origin of the centrosomes of the first maturation division; on the other hand they may, as indicated above, receive substance which escapes in a dissolved condition from the nucleus during every mitosis.

Whatever the ultimate origin or phylogenetic relationships of the centrosome may be, there is a remarkable parallelism between it and the nucleus, as the following statements will show:

1. Both begin their developmental cycle as small granules, the central corpuscle in the case of the centrosome, the chromosomes in the case of the nucleus.

2. Both grow enormously by the absorption of surrounding substances and become vesicular; in the cleavage of the egg the vesicular condition is followed by a reticular condition in both.

3. Both undergo radical changes in their staining qualities during this enlargement, passing from a condition in which they are uniformly chromatic to one in which they are almost entirely plasmatic in reaction; finally, they again become largely chromatic, so that the centrosomes in the resting stages of certain cells look like small nuclei filled with a chromatic reticulum (*cf.* figs. 69, 73, 74, 75).

4. When they have reached their greatest volume both are proportional in size to the size of the cell-body in which they are found; this probably indicates that the substances absorbed by both in their growth are derived from the cytoplasm.

5. In both, the daughter structures (centrosomes or nuclei) are but a fraction of the mother organ, the remainder of the latter passing sooner or later into the cytoplasm.

The centrosome thus repeats the history of the nucleus; at one period it takes up substances from the cytoplasm; when it has reached its greatest size the new centrosomes and central spindle arise within the mother centrosome from a part of

its substance, and the remainder of the latter passes back into the sphere and ultimately into the cytoplasm. It is evident from this description that, as in the case of the nucleus, so also in the centrosome there is a sort of diastole and systole, the phases of the one alternating with those of the other.

(*d.*) *Comparisons.*—I have found centrosomes, similar in all respects to these just described, in three species of *Crepidula*, and in *Urosalpinx*, *Illyonassa*, *Fulgur*, *Sycotypus*, and *Aeolis*. In structure and history the centrosomes in all these gasteropods are similar to those which have been observed in *Diaulula* (MacFarland, '97), *Unio* (Lillie, '98), *Thysanozoon* (Van der Stricht, '98), *Rhynchelmis* (Vejdovsky, '88, and Vejdovsky and Mrazek, '98), *Actinosphaerium* (R. Hertwig, '99), and *Haminea* (Smallwood, '01), while they bear many resemblances to those which have been observed in *Echinus* (Boveri, '01), *Ascaris* (van Beneden, '87, Boveri, '88, '01, Brauer, '93, Fürst, '98), *Sida* (Häcker, '93), *Salamandra* (Rawitz, '96, Niessing, '99), *Salmo* (His., '98), *Fulgur* (McMurrich, '96), *Limax* (Byrnes, '96 and '99, Linville, 1900).

Van der Stricht's interpretation of the relations of the centrosome to the attraction sphere in *Thysanozoon* seems to me most satisfactory, not only because he has for it the approval of Van Beneden and Boveri, but also because by it the various forms of centrosomes present in the animals named above and particularly the remarkable centrosomes of mollusca can be satisfactorily related to one another and to other forms. We need not here concern ourselves with the origin of the centrosomes of the first maturation; Van der Stricht believes that they arise from the nucleus, and this view is supported and extended by the recent observations of Schockaert (1900). Soon after its appearance the centrosome of *Thysanozoon* is differentiated into a central corpuscle and a medullary zone (*couche médullaire*). These two together constitute the centrosome of Boveri, the central corpuscle being his centriole. The medullary zone is homogeneous in structure, and no astral fibres penetrate it except at the time of origin of the new spindle figure; it is usually bounded peripherally by a dark line (in reality a sphere).[1] Around this is a clear area traversed at all stages by delicate astral fibres; this is the cortical zone (*couche corticale*), and it is possible that it is derived, in part, from the centrosome. Around this is the zone of astral rays, which sometimes may be subdivided into an inner dark and a peripheral clear zone. The centrosome and cortical zone continually enlarge, as the division advances, until they reach a great size. In the division of this centre, the central corpuscle first divides, usually into two, and the central spindle appears between the halves; the medullary zone then becomes bounded by granules, and this boundary gradually fades from view, though Van der Stricht believes that the entire attraction sphere persists and divides, thus giving rise to

[1] The clear zone which is so generally found around the central corpuscle is believed by many observers to be the result of destaining. Such a zone is produced by destaining yolk-spheres, nucleoli, etc. Fischer ('99) calls this "Spiegelfärbung." It will be observed that the manner in which these centrosomes stain, which have a dense periphery and clear central area, is the exact reverse of "Spiegelfärbung."

the daughter attraction spheres. The relations of the parts of the centrosome, the attraction sphere and the aster of *Thysanozoon* may be indicated as follows :—

Centrosome { Central Corpuscle
Medullary Zone } of Attraction Sphere.
Cortical Zone
Inner Zone } of Aster.
Peripheral Zone

The most important points in which my observations differ from those of Van der Stricht are the following :—

1. The peripheral boundary of the centrosome (medullary zone) is much denser and more deeply staining than in *Thysanozoon*.

2. During the rest stages in the cleavage the central corpuscle is represented by an enormous number of granules, only two of which form the new centrosomes.

3. Neither the medullary nor the cortical zones of the attraction sphere ever divide as a whole, but after the origin of the new amphiaster they are slowly dissolved in the cytoplasm.

4. The central corpuscle of one generation gives rise to the entire centrosome, *i. e.*, central corpuscle and medullary zone, of the next.[1] This is most plainly seen in the anaphase of the first maturation.

5. At no time do the astral rays traverse the medullary zone,[2] though new rays which are not part of the old system may arise within that zone around the new centers.

In *Diaulula*, according to MacFarland, the centrosome increases greatly in size from the prophase to the anaphase and a single granule appears within it. This granule soon divides into two which move apart and become the new centrosomes. The whole of the old centrosome is transformed into the new centrosomes and central spindle. The rays are inserted on the centrosome, not on the central granule. Even after the new spindle figure has reached a considerable size the rays continue to be centered on the figure as a whole.

My observations differ from MacFarland's only in one respect: The whole of the old centrosome is not transformed into the new spindle figure, but the latter arises *within* the old centrosome. This is plainly true of the maturation stages, corresponding to those which MacFarland has studied, and in the first three cleavages, but the case is not so clear in the later cleavages, as a glance at my figures 74–76 will show.

According to Lillie ('98) each centrosome in the prophase of the second matur-

[1] I am not quite certain whether this may not be involved in Van der Stricht's statement that the centrosome becomes differentiated into a central corpuscle and medullary zone. The fact, however, that he maintains a persistence of the attraction sphere leads me to suppose that he regards each medullary zone as derived from a preexisting one.

[2] In this important respect my observations agree entirely with those of Boveri and his pupils, MacFarland and Fürst, and differ from those of Van Beneden. Indeed, it may be doubted whether the term "medullary zone" should be applied to a structure which shows no radiations. Other considerations, however, render it extremely probable that the peripheral layer of the centrosome in gasteropods and the "medullary zone" of *Thysanozoon* are homologous.

ation division of *Unio* is composed of several large granules into which rays are inserted. In the metaphase these granules subdivide, and some of the fragments are distributed in the form of a sphere, the "inner sphere;" "one of the granules remains behind as the centrosome of the new inner sphere," but "a large part of the centrosome granules is changed into the red-staining substance of the sphere." In the anaphase the granules of the inner sphere, together with the peripheral accumulation of its ground substance, fuse into a continuous membrane. "The centrosomes are united to the membrane of the inner sphere by a few irregular threads which are not part of the system of radiations." Within the sphere the daughter centrosomes and central spindle arise.

Lillie emphasizes the fact that the inner sphere is not the centrosome, and he says that Boveri's "centrosome" is really the inner sphere, while his "centriole" is the real centrosome. He also holds that MacFarland's "centrosome" is really the inner sphere.

Lillie's conclusions seem at first sight to be very different from any of those mentioned above, and yet on consideration it will be seen to be rather a difference of terms than of facts. His "inner sphere" is undoubtedly homologous with Boveri's centrosome, his "centrosome" with the central corpuscle or "centriole" of Boveri. As to the genesis of these parts, I have never been able to observe the formation of the "inner sphere membrane" from granules derived from the central corpuscle as Lillie has done, nor have I observed the fragmentation of the central corpuscle and the transformation of these granules into the ground substance of the centrosome (substance of medullary zone), though in early phases the centrosome of *Crepidula* is irregular in outline, as if composed of closely connected granules. In all cases which I have observed the central corpuscle enlarges but does not fragment; its substance accumulates peripherally and forms a continuous membrane which *subsequently* is transformed into a layer of granules. If the central corpuscle of *Unio* were to remain a single structure, and were to continually expand, the result would not be unlike my observations. The one critical point in the comparison of Lillie's observations with those of other investigators, is to determine whether the whole of his "inner sphere" is derived from the central corpuscle; if it is, the differences are only matters of detail. It should be remembered that, according to Lillie, the inner sphere is itself a structure which sooner or later disintegrates and passes into the outer sphere or cytoplasm, and that it should disintegrate at different stages in different eggs is quite possible.[1]

In a later paper on the subject, Lillie ('99) says that the inner sphere enlarges very rapidly after the formation of the second polar body, and its substance gradually merges with the general cytoplasm. Its interior is occupied by the vesicular sphere substance at the nodes of which are deeply staining granules. In this respect there is considerable difference between *Unio* and *Crepidula*, for in the latter the inner

[1] I ought to add that I have had the pleasure of seeing Lillie's beautiful preparations, and they leave no ground for doubting the accuracy of his observations. Professor Lillie also personally assures me that he is quite convinced that the whole of the "inner sphere" is derived from the central corpuscle. (See also his recent work, 1900, p. 242.)

sphere remains much smaller and persists for a considerable period, while the outer sphere undergoes a metamorphosis similar to that which Lillie describes. The inner sphere is very faint and difficult to detect in *Crepidula*, and it may be that Lillie has overlooked it, or it may disintegrate sooner in *Unio* than in *Crepidula* (*cf.* my fig. 36 and Lillie's ('99) fig. 14).

Vejdovsky ('88) found in the egg of *Rhychelmis* immediately preceding the first cleavage, a hyaline sphere, the "Periplast," within which in the course of cell-division a new element, the "Tochterperiplast" appears; the latter divides into two spheres which represent the poles of the new spindle. During the first and second cleavages a new element, the "Enkelperiplast" arises within the "Tochterperiplast," while the "Mutterperiplast" degenerates or fuses with the cytoplasm. This was the first observation tending to show that the new centers arise endogenously within the old.

More recently Vejdovsky and Mrazek ('98) have confirmed and extended this account. They find at the poles of the first cleavage spindle, a large sphere at the center of which is a deeply staining granule, the "centrosome" (central corpuscle); this is surrounded by a hyaline sphere the "Tochterperiplast" (medullary zone), at the periphery of which the rays are attached; surrounding this is the "Mutterperiplast" (cortical zone). For the sake of uniformity we shall use the terms in parenthesis in place of Vejdovsky's terminology. As mitosis advances the medullary zone (Tochterperiplast) grows rapidly, becomes reticular or alveolar in structure and is bounded by a dense peripheral zone; the central corpuscle decreases in size and stains less densely, while radiations appear around it within the medullary zone. Around the central corpuscle a new medullary zone appears within the old one. The central spindle is formed, after which the new medullary zone divides. Vejdovsky and Mrazek consider that centrosome and periplast are persistent organs of the egg and that they represent a single whole. The entire periplast, however, does not persist, but the inner zones give rise to the outer ones which gradually disintegrate into the cytoplasm.

The resemblances between these observations and those which I have described in the preceding pages are very striking. The only important difference between my own observations and those of Vejdovsky and Mrazek is the following: A new medullary zone does not form around the central corpuscle before the latter divides, but only afterwards, *i. e.*, in the mollusks which I have studied the two daughter centrosomes are present before a new medullary zone is formed.

R. Hertwig has observed in *Actinosphærium* a large "spongy centrosome" within which a "reduced centrosome" (central corpuscle) appears and divides into two; the latter then enlarge to form new "spongy centrosomes," while the former "spongy centrosome" does not divide, but disappears in the cytoplasm. The resemblances in this case to those discussed above are too obvious to need comment.

In *Limax*, Byrnes ('99) has found centrosomes which in many respects resemble those of *Unio*, *Crepidula*, *Aeolis* and other mollusks. In the metaphase of the first maturation there is at each pole a group of central granules, within a clear area, which is surrounded by a broad, densely staining zone. In the anaphase the

central granules divide into two groups and a spindle appears between them and within the "centrosphere." From my own observations I am convinced that both the central clear area, with its contained granules and the denser zone which surrounds it, belong to the centrosome, which, when fully formed in the anaphase, consists of central corpuscles and medullary zone, the latter bounded by a narrow line or layer of granules. If this be correct the spindle in *Limax* arises *within* the medullary zone, as in many other cases.

Linville (1900) has observed a similar centrosome in *Limax* and other Pulmonates, around which is a cortical zone of radiating structure. He has not followed the metamorphosis of the centrosomes in detail, but his figures give evidence that the history of the centrosome in these Pulmonates is not different from what is known in other mollusks.

Finally, it seems quite possible to interpret most of the multitudinous forms of centers which have been described in the eggs of various animals in accordance with the Van Beneden-Boveri idea, as extended and defined by Van der Stricht, and particularly by Boveri (1901), provided that the remarkable changes in the structure of the centrosome from prophase to telophase be kept in mind. In mollusks the centrosomes are characterized (1) by the great breadth and density of the peripheral portion of the centrosome which, about the middle stage of mitosis, forms a dense ring or sphere surrounding a clear area, and which in all stages sharply separates the centrosome from the surrounding sphere, (2) by the fact that the centrosomes grow to an unusual size during mitosis, and (3) by the origin of the entire amphiaster of one generation within the centrosome of a preceding one. Possibly the second and third of these characteristics are the results of the first, since the sharp boundary of the centrosome at all stages make it unusually easy to recognize the great growth of the centrosome and also the place of origin of the new centrosomes and central spindles.

Boveri's ('01) masterful contribution on the nature of the centrosome reached me some time after my paper had been completed, and I have therefore been unable to make the extended use of it which I could have desired. In broad outlines my conclusions as to the centrosome are fundamentally like those of Boveri. The one most important point of difference between us is that Boveri considers the centriole as a differentiation of the centrosome, perhaps a continuous and persistent structure, around which a portion of the centroplasm always remains to form the new centrosome. On the other hand, I hold with R. Hertwig ('99) that the centriole gives rise by growth to a centrosome, within which a daughter centriole differentiates, *i. e.*, the centriole undergoes in its cycle of development a metamorphosis into centrosome and daughter centriole. In each generation the outer zone of the centrosome is thrown off, while the new centrosomes and central spindle come from the center of the old. There is thus a kind of endogenous formation of centrosomes, as Vejdovsky and Mrazek maintain.

Since receiving Boveri's paper I have carefully re-examined the critical stages in my preparations to see whether I could have overlooked an outer zone of centro-

plasm around the deeply staining body at the center of the aster. There is a faintly staining zone surrounding the central body in the prophases both of the maturation and cleavage divisions (see figs. 4–7, 26–30, 52–56, 70–72, 76), but this zone according to Boveri's definition, does not belong to the centrosome, since even at its first appearance (cf. fig. 70) it is traversed by radiations; furthermore, a study of consecutive stages shows that it develops step by step into the inner portion of the sphere. On the other hand, I believe that I have followed the central, deeply staining body through every stage of its growth and metamorphosis, having seen it not merely in the stages represented in the plates, but in thousands of others, many of which were carefully drawn. The result of this study convinces me that the small, deeply staining granule of the early prophase becomes the dense, spherical body of the metaphase and the large, hollow sphere of the anaphase, and that this body is the centrosome. The fact that in the mollusks generally the peripheral layer of the centrosome stains more densely than the central portion, makes it unusually easy in these animals to distinguish between the centrosome and the surrounding sphere. The result therefore of the re-examination of my preparations in the light of Boveri's work does not in any respect lessen my confidence in the accuracy of my observations and interpretations, at least as far as *Crepidula* is concerned.

The type of centrosome represented by *Crepidula*, *Unio*, *Haminea* and *Aeolis*, viz., one within which the new centers and central spindles arise from the centriole while a considerable part of the mother centrosome fades away into the sphere, agrees much more closely with the types of centrosomes found in *Ascaris*, *Thalassema* and *Echinus*, than does that of *Diaulula*. Boveri represents these four types in text figures (pp. 102–103), and it can be seen at a glance that in the first three types the daughter centers and spindles occupy but a small part of the old centrosome, whereas in the fourth type (*Diaulula*) they occupy the entire centrosome. I have found that the relative size of the central spindle and daughter centrosomes (Netrum of Boveri), as compared with the inclosing centrosome, differs considerably in different cleavages of the egg. Thus in the first, second and third cleavages the netrum is much smaller than the mother centrosome, whereas in the fourth, fifth and later cleavages the netrum almost entirely fills the mother centrosome. In view of these facts I venture to suggest that a re-examination of *Diaulula* with regard to this point might show that the outlines of the netrum are not coincident with those of the mother centrosome, but that the former lies *within* the latter as is the case in the other mollusks named above, as well as in other types of centrosomes described by Boveri.

(*e*) *The Centrosome as a Persistent Cell Organ.*—There is no more perplexing problem in connection with the cell than that of the significance of the centrosome. On the one hand there are the well established facts as to (1) its persistence from cell cycle to cell cycle (my own observations showing that in the cleavage of *Crepidula* it persists without interruption to a stage with more than sixty cells and probably throughout the entire development); (2) its independent growth and

division (shown not only by observation in many animals, but particularly by Boveri's ('97) experiments on echinoderm eggs); (3) its characteristic structure and metamorphoses, which in a large number of animals (perhaps in all) can be reduced to a common type.

These features are of such character and importance that they justly entitle the centrosome to the rank and title of a permanent cell organ (Van Beneden, Boveri). One who has followed the history of the cleavage centrosomes through several cell cycles, who has observed their unfailing persistence, the regular cycle of changes in form and staining reactions which they undergo, their complex structure, their form of division, their parallelism in these and in other respects to the nuclei (see p. 55), can no more doubt that these centrosomes are persistent cell-organs than that nuclei or plastids are.

On the other hand there are the well known facts (1) that, according to the best testimony, there are no centrosomes whatever in the higher plants (Strasburger, Osterhout, Mottier, *et al.*); (2) that the persistence of centrosomes has been denied in the tissue cells of some animals, and even in certain stages of the egg, particularly during fertilization (Foot, '97, Lillie, '98, Child, '99); (3) that various stages intermediate between centrosomes and microsomes or other cytoplasmic constituents have been described (Bürger, Reinke, Watase, Mead, Eismond, Erlanger) which indicate that the centrosome is only a temporary differentiation of the cytoplasm; (4) that artificial asters and centrosomes may be formed in egg cells by the action of various solutions, and that these may function as normal asters and centrosomes (R. Hertwig, Morgan, Loeb, Wilson).

The contradiction between these two classes of evidence is so complete, and the phenomena in both classes are apparently so well attested, that one would be inclined to seek refuge in the conclusion that in some cases the centrosomes are persistent cell organs and in others temporary structures, were it not for the fact that this contradicton may concern one and the same object (*e. g.*, the eggs of Echinoderms and of *Chætopterus*).

There is certainly no ground to doubt that in the cleavage of the eggs of many animals the centrosomes are, under normal conditions, absolutely continuous from cell generation to cell generation. Nor is there any possibility of doubting that in certain animals the centrosomes show independent growth and division, and that they pass through certain characteristic metamorphoses in this cycle. The only possible interpretation of these undoubted facts is that, in some cases at least, the centrosome is a cell organ of morphological as well as of physiological significance.

Is the contrary evidence irreconcilable with these well established facts, and must we, therefore, conclude that the persistence of centrosomes, their growth, metamorphoses and division have no general morphological significance? I think not.

(1) If it be granted that the centrosomes are not present at any stage in the cell cycle in the higher plants, this does not necessarily contradict the centrosome theory of Van Beneden and Boveri, since the fact that they are present in the lower plants indicates that their absence in the higher plants must be the result of degene-

rative changes. If, however, centrosomes may degenerate in whole classes of the plant kingdom, the centrosome is surely neither so ubiquitous nor so necessary a cell organ as the nucleus.

(2) So far as animals are concerned the centrosome has been found in almost all kinds of metazoan cells, and at nearly every stages of the cell cycle. The history of biology shows that the failure to find structures, even by many observers, is no proof that they do not exist, and this is particularly the case with structures so difficult to observe and undergoing so great metamorphoses as the centrosomes. As to the alleged disappearance of the centrosome in the fertilization of the egg (Foot, Lillie, Child,), it must be said that this like negative evidence in general is not wholly conclusive. Certainly, so far as my own work goes, I cannot affirm that both egg and sperm centrosomes entirely degenerate, although they do disappear, nor can I affirm that the cleavage centrosomes are new formations, although I am unable to trace any connection between them and the centrosomes of the egg and sperm. Even if these centrosomes disintegrate, it may be that the new centrosomes arise from some of their fragments; in fact, such would seem to be the case in *Crepidula* (see p. 27). The history of the centrosomes in the fertilization is at best a complicated one, and is by no means as clear as in the cleavage of the egg or in the division of tissue cells, and until we have more exact knowledge of the origin of the centrosomes in the fertilization, this doubtful evidence against the continuity of the centrosomes should not be permitted to outweigh the positive evidence in favor of their continuity afforded by ordinary mitoses.

(3) The view that the centrosome is only the meeting point of astral rays or that it represents merely a condensation of the cytoplasm, or that it is an enlarged microsome, entirely neglects to take account of the complex structure and metamorphoses of the centrosome, as well as of its division and persistence. These are by all odds the most characteristic features of a centrosome, and until it has been shown that the cytoplasmic structures mentioned above are capable of reproducing these characteristic features, it may well be doubted whether they are really centrosomes. The mere formation of cytoplasmic radiations is in itself no positive indication of the presence of a centrosome, since such radiations are found in the higher plants where centrosomes are wholly lacking (Osterhout, Mottier), in non-living substances such as carbolic acid and chloroform, gelatin and albumen (Roux, Bütschli, Fischer), where there is certainly no centrosome with the characteristics described above; around mid-bodies (see figs. 60, 61), and in many of the multiple and accessory asters found in cells under normal and artificial conditions, which show no body at the center of the rays (Mead, Lillie, Morgan, *et al.*).

(4) The fourth class of facts which speak against the theory of the persistency and morphological importance of the centrosome forms by all odds the most serious objection to that theory which has yet been raised; I refer to the experimental production of centrosomes both in fertilized and in unfertilized egg cells by the action of various solutions (R. Hertwig, Mead, Morgan, Loeb, Wilson). It may well be doubted whether all of these structures are centrosomes, but that some of them

are such is beyond dispute. Certainly, structures which function as centrosomes through a long period leading up to the production of larvæ (Loeb, Wilson), are enough like centrosomes to pass under that name. And even in cases where larvæ are not produced (experiments of Hertwig, Mead and Morgan), there can be no reasonable doubt that centrosomes are found in the larger asters, even if the smaller ones do not contain them.

In the case of Morgan's experiments on fertilized eggs it might be maintained that the numerous asters and centrosomes observed are derived by division or fragmentation from those already present in the cell-body, where it not for the fact that similar asters and centrosomes have been observed in the case of unfertilized eggs (Hertwig, Morgan, Wilson) where no centrosomes are present in the cytoplasm. The phenomena in these two cases are so similar that one cannot believe that they are due to wholly different causes; we may, therefore, safely class them together.

Hertwig maintains that in his experiments the centrosomes were formed from the achromatic constituents of the nucleus. He says: "Ich deute somit die Centrosomen as selbständige gewordene geformte achromatische Kernsubstanz, eine Deutung für die ich wiederholt eingetreten bin." In part Morgan agrees with this position, though he also holds that centrosomes may arise at a distance from the nucleus and therefore from the cytoplasm. "I agree," he says, "with Hertwig that the centrosomes may develop out of the achromatic substance of the nucleus, but I see no ground to extend this statement to include all centrosomes. . . . There is good evidence to show, I think, that similar bodies may arise in the cytoplasm also, as shown by Reinke, Mead, Watase and myself." It is a notable fact, however, that in all these cases cited by Morgan the nuclear membrane has disappeared or is much shrunken and collapsed, showing that nuclear substance has escaped from it. This is true at least of the figures of Reinke, Mead and Morgan; Watase gives no figures of the egg of *Macrobdella* which he describes as containing "a series of thirteen asters, ranging from the miniature aster, with the microsome in its center, to the normal aster with a veritable centrosome." In the figures of Reinke, Mead and Morgan one is much struck by the fact that at the time when the asters appear in the cell the nuclear membrane is either entirely lacking or is much shrunken, showing that achromatic material has escaped into the cell. Of his own experiments Morgan says (p. 464): "The first effect (of the salt solution on the egg) is to cause a shrinkage of the nucleus; then after the return of the eggs to sea water the division of the nucleus and subsequently that of the egg takes place; . . . central bodies are present in the artificial astrosphæres in almost all the stages." Again (p. 517) he says: "At the time when the nuclear wall disappears the astrosphæres throughout the egg, whether in contact with the chromosomes or not, become conspicuous and then fade away again as the chromosomes pass into the resting nuclei. There is some connection between the setting free of the chromosomes and the development of the astrosphæres;" or rather, as it seems to me, between the escape of some nuclear constituent and the development of the astrosphaeres. The fact that achromatic nuclear substance may be distributed widely through the cell in normal mitoses was pointed out in the section on aster

formation, and I see no evidence in the cases brought forward by Morgan to indicate that the centrosomes or asters in all these cases may not be derived from escaped nuclear material.[1]

There is certainly a close relationship between the nuclei and the centrosomes. The achromatic substance of the nucleus contributes to the growth of the centrosome in every normal cell cycle (see p. 54), and it is probable that the daughter nuclei in their growth resorb from the spheres a portion of this same achromatic substance. The peripheral spindle fibres are formed out of this substance (*viz.*, linin and oxychromatin), and bear a striking resemblance to the central spindle fibres at an early stage (*cf.* figs. 55 and 75). In the first maturation of the egg the centrosomes or asters do not appear until substances have escaped from the nucleus, as is shown by the breaking or indentation of the nuclear membrane (*cf.* Coe '99, Carnoy and Lebrun '99, Gardiner '98, Griffin 1900, Mead '98, Van der Stricht '98, Schockaert 1900), and, finally, the granular or reticular centrosome undergoes the same changes in reaction to stains as does the oxychromatin and linin, being at one time uniformly chromatic, and later uniformly plasmatic in reaction. In all these respects the centrosome behaves like an isolated portion of the oxychromatin and linin.

A large number of investigators have observed the formation of centrosomes and spheres from some of the nuclear constituents, particularly among the Protozoa, (Brauer '93 in *Ascaris*, Rückert '94 in *Cyclops*, Ishikawa '94 and Calkins '98 in *Noctiluca*, Balbiani '95 in *Spirochona*, Schaudinn '96 in *Acanthocystis*, Hertwig '99 in *Actinosphærium*, *et al.*).

[1] Wilson's ('01) recent work on *Toxopneustes* shows that asters and centrosomes may arise in eggs treated with $Mg\ Cl_2$, not only far from the nucleus, but even in enucleated fragments. Wilson says (p. 542) "There is absolutely no evidence for, and the clearest evidence against, the view that the original cytasters form at or near the nucleus, to migrate thence toward the periphery, or that they arise by the multiplication of a single primary center." He holds, therefore, that centrosomes and asters may arise *de novo* in the cytoplasm. Such a view, if generally true, would be fatal to the one which is set forth in this paper, and it deserves more extended treatment than can be accorded to it in a foot-note. In brief, the critical questions as to Wilson's experiments are these: (1) Are the bodies in question real centrosomes; (2) do they arise *de novo* in the cytoplasm? I am not disposed to question the fact that these bodies are really centrosomes, but I am inclined to doubt the statement that they arise *de novo*, if by that it is meant that they arise without genetic relation to other centrosomes or to the nuclei. The fact that these "artificial" centrosomes may appear far from a nucleus, or even in enucleated fragments, does not necessarily imply that they are wholly independent of them. The achromatic substance of the nucleus may be widely distributed throughout the cell during mitosis, and I have observed in the eggs of *Crepidula*, which have been placed in 2%–3% Na Cl for several hours, that the achromatic portion of the nucleus may exist as one or more vesicles, with definite walls, quite distinct from the chromatic portion. In some cases these achromatic vesicles are in contact with the chromatic one; in others they are widely scattered throughout the entire cell. *Furthermore, many of these vesicles apparently give rise to centrosomes.* If the achromatin of the nucleus is genetically related to the centrosome as I have maintained in this paper, and if achromatin, diffused throughout the cell, may, under certain stimuli, be aggregated into vesicles, which then give rise to centrosomes, Wilson's observations need not necessarily mean that centrosomes arise *de novo.*

In all cases in which "artificial" asters and centrosomes have been produced, a large amount of nuclear substance has been present in the cytoplasm. No one, so far as I can recall, has observed asters in egg cells while the germinal vesicle is still intact; with the escape of achromatin from the germinal vesicle, however, numerous asters and possibly centrosomes may appear in the egg. I have tried by various means to produce asters in egg cells before maturation, but always without success as long as the germinal vesicle remains intact. I believe that it may be laid down as a general principle that *escaped nuclear material is essential to the formation of an aster, and that an aggregation of such material is necessary to the formation of a centrosome.*

Others have observed that centrosomes disappear within the growing daughter nuclei in certain cases. For example, Mead says that the centrosome left in the egg at the close of the second maturation of *Chætopterus* is last seen "in the midst of the fusing (chromosomal) vesicles, its position being indicated by the point of convergence of the rays of its waning aster." Exactly the same thing is true of *Cerebratulus* (Coe), *Thalassema* (Griffin), *Asterias* (Wilson and Mathews) and probably of other animals. In all these cases the centrosome is probably taken into the egg nucleus.

All of these facts seem to me to indicate that the centrosome is intimately related to the "formed achromatic" substance of the nucleus and that, in some manner, artificially produced centrosomes are formed out of this material as R. Hertwig maintains.

Loeb has found, by a series of remarkable experiments, that artificial parthenogenesis may be caused in the eggs of echinoderms and of *Chætopterus* by the action of a variety of substances upon the eggs, and he concludes that in general this parthenogenesis is the result of diosmotic action of these substances and the withdrawal of water from the egg, though other factors also enter into the problem in the case of *Chætopterus*. In the light of the many observations and experiments which go to show that asters and centrosomes are produced from escaped nuclear material, the thought suggests itself that artificial parthenogenesis may be caused by any method which will bring certain nuclear constituents into the cell body and yet not seriously injure either nucleus or cytoplasm.

One of the most interesting chapters of Boveri's recent work on the centrosome is that in which he undertakes to account for the production of centrosomes by artificial means. Boveri recognizes, as have many others, the intimate relation between the achromatic material of the nucleus and the centrosome. In cases where real centrosomes can be produced from unfertilized eggs he holds that they are formed by a kind of regeneration (*reparation*, Driesch '97) from the achromatic substance of the nucleus. Not all nuclei, however, have this power, and, accordingly, Boveri distinguishes between (1) *nuclei* which are purely nuclear in character, and (2) *centro-nuclei* which contain a cytocenter. An example of the former is found in *Ascaris*, and of the latter in many Protozoa, and in some Metazoa, particularly in the echinoderms and in the ovocytes of many animals—perhaps of all.

The question at once arises: What reason is there for supposing that among Metazoa nuclei are divided into these two classes? Boveri himself has asked this question, and he concludes that in *Ascaris* at least the nucleus cannot be a centronucleus, since in certain pathological eggs, in which the spermatozoon remained at the periphery or did not enter at all, the egg went through the maturation divisions and the egg nucleus came to the period of the solution of the nuclear membrane without a trace of fibre differentiation, of centrosomes, or of spindles or spheres. He therefore concludes that the nucleus of *Ascaris* is a pure nucleus which has lost the capacity of forming centrosomes.

The evidence upon which such an important generalization is based seems to

me to be insufficient. No small amount of evidence is required to prove that nuclei, which are so similar in all other respects, are so different in this one. I agree with Boveri that research only can determine where (and I should add whether) this is true.

Returning now to Boveri's idea that in the artificial production of centrosomes they are formed by a kind of regeneration:—Morgan's experiments make it extremely probable that numerous centrosomes may be formed independently of each other in the cytoplasm. If these are formed of achromatic nuclear material it is easy to understand that they appear wherever a sufficient accumulation of this material is found in the cell body. But achromatic material separated from the nucleus is not necessarily a centrosome with all of the morphological and physiological features which that body exhibits, as is shown by the fact that such material is distributed through the cell at every mitosis. Either there must be an escape of some centrosomal substance or structure, or the condition of the cell must be such as to bring about centrosome formation from ordinary achromatic material; the latter is I believe Hertwig's view (see quotation on p. 64); the former is held by Boveri who considers that the centrosome may be regenerated (repaired) from the achromatic substance of centro-nuclei only.

This very suggestive hypothesis of Boveri's makes it possible to harmonize the well established fact of the persistence of the centrosome as a cell organ with that other apparently contradictory fact that centrosomes may be produced experimentally in the cell; and this it does by practically adding another phase to the series of changes through which the centrosome may pass, *viz.*: the phase of the centronucleus.

But the question of the persistence and morphological significance of the centrosome does not hang on the fate of the uncertain hypothesis that nuclei belong to two classes, pure nuclei and centro-nuclei. The one point of importance is that centrosomes are not coagulation products, nor the mere expression of cell stresses, nor sporadic or spontaneous structures, which may appear and disappear here, there or anywhere, depending upon the physiological condition of the cell; but that all kinds of centrosomes, whether normal or artificial, are formed of a specific kind of protoplasm which is genetically related to the achromatic substance of the nucleus, from which, under certain conditions, they may be formed anew, that they have a characteristic structure and metamorphosis, that they possess the power of independent growth and division, and that they are therefore cell organs, which are at least relatively, even if not absolutely, persistent structures of high morphological significance.

(*f*) *Homology of the Centrosome.*—We may now again consider the parallelism between the nucleus and the centrosome pointed out in a previous section (p. 55). This parallelism is seen not only in the alternate growth and diminution of both, but also in corresponding changes in staining reactions and in similarities in their modes of self propagation, both nucleus and centrosome being continued from generation to generation by means of small granules (chromosomes, central corpuscles) which have the power of independent growth and division.

What is the significance of this parallelism between the nucleus and the centrosome? Does it indicate that these two structures are genetically related or may it be due to simpler physical or physiological factors? The parallelism in the *growth and diminution* of these structures indicates that both nucleus and centrosomes are diffusion centers which alternately enlarge by the absorption of substances from the cell body and diminish by the return of substances to the cell body. It is possible that their parallel changes in *staining reactions* are the results of the absorption of similar materials from the cell body, or it may be due to the fact that the centrosomes imbibe a certain amount of material which escapes from the nucleus. The fact that they are both *self propagating* is a property which they share in common with other cell constituents (*e.g.* plastids) with which they are certainly not homologous.

On the other hand the remarkable manner of this self propagation is shared, I believe, by no other cell constituents. Moreover, the singular resemblance between the reticular central spindle (netrum), the achromatic reticulum within the nucleus and the intranuclear spindle of many of the Protozoa is most striking and finds no satisfactory explanation along the lines just indicated.

Many persons who have worked upon nuclear division in the Protozoa (*e.g.* Bütschli ('91), R. Hertwig ('92, '99), Schaudinn ('95, '96), Lauterborn ('96), Calkins ('98) have pointed out the resemblances between micro-nucleus or the intra-nuclear mitotic spindle and the centrosome of the Metazoa, and this homology has been maintained with great force by Heidenhain ('94) and Boveri ('01).

R. Hertwig in particular has repeatedly advocated this homology. In *Actinosphaerium* he has observed that the centrosomes are actually budded out of the nuclei, and he concludes that the centrosomes are to be considered an escaped achromatic substance of nuclear origin, "nuclei without chromatin." He has also pointed out the steps by which, he thinks, the evolution of the centrosome has taken place, as well as the phylogenetic relationships of the various types of centrosomes to each other and to the nuclear structures of the Protozoa.

Heidenhain also has forcibly presented the resemblance between the central spindle of the Metazoa and the micro-nucleus of the Infusoria. He concludes that the two are homologous, that the centrosomes of the Metazoa are only polar differentiations of the intra-nuclear spindle of the Infusoria, while the macro-nucleus of the latter corresponds to the nucleus of the Metazoa; the chromatic substance of the micro-nucleus has disappeared in the Metazoa, being transformed into the archoplasm zone.

These ideas of Heidenhain called forth the severe criticism of Boveri ('95) who held that since the Infusoria cannot possibly represent the ancestors of the Metazoa, the nuclear structures and functions which occur in these cannot properly be considered the prototypes of those in the Metazoa. Further, he held that the macronucleus was probably a transformed micro-nucleus, and that actual, independent centrosomes were present in some Protozoa.

It is interesting to find that in his recent work on the centrosome Boveri ('01),

while still maintaining some of the propositions named above, acknowledges that his opposition to the view that the intra-nuclear spindle of the Protozoa is the homologue of the metazoan centrosome was not justified. The fact that so careful and far seeing an investigator as Boveri should find cause to reverse his position on this question lends additional weight to this idea.

Boveri compares in detail the micro-nucleus of a ciliate infusorian in the spindle stage, the ovocytic spindle of *Ascaris*, the nuclear spindle of *Opalina*, which does not fill the whole of the nuclear cavity, the ovocytic spindle of *Diaulula*, which lies entirely outside of the nuclear cavity and in which centrosomes have differentiated at the poles of the spindle, and finally a type such as *Ascaris* (cleavage stages) in which the central spindle connecting the centrosomes has almost entirely disappeared. In this series is shown the supposed steps by which the centrosome is differentiated at the poles of the spindle-shaped figure (netrum) and by which the latter comes to lie outside of the nuclear cavity and separate from the chromosomes.

How entirely my observations on *Crepidula* and other gasteropods accord with the general homology suggested by these different investigators can be seen at a glance at my figures. Compare for example the cleavage centrosomes of *Crepidula* (text fig. IV and Plate IV, figs. 69–76) with the micro-nucleus of *Paramœcium* (Hertwig):[1]

(1) In the resting stage both are reticular spheres; (2) As the division begins they become spindle shaped and the reticulum is drawn out into spindle fibres; (3) At the poles of this spindle pole bodies (plates) appear, the spindle and pole bodies forming a unit structure (Heidenhain); (4) In this process the centrosomes of *Crepidula* repeat some of the very stages which the authors named above assume to have occurred phylogenetically, *i. e.*, the reticular spindle when first formed shows no sharply differentiated body at its poles; later a centrosome appears at each pole, whether as a new differentiation or from a granule before indistinguishable from the others I cannot decide.

In one respect, however, there is an important difference between the centrosomes of these gasteropods and the micro-nuclei of *Paramœcium* or other Ciliata, *viz.*: in the former the new spindle figure (netrum) is formed within the old centrosome, the outer zone of which disintegrates. This resembles the observations of Hertwig on *Actinosphaerium*, but is unlike the division of the micro-nucleus of the Infusoria where the membrane persists throughout the division.

On the other hand the disintegration of the centrosomal membrane in gasteropods precisely resembles the behavior of the nuclear membrane among Metazoa; this membrane which is composed of substances similar to, if not identical with the formed achromatic substance (oxychromatin and linin) dissolves and disappears during mitosis, just as the centrosomal membrane does. Both nuclear and centrosomal membranes, like their contents, undergo similar changes in staining reactions

[1] There is also a striking resemblance between the form of division of the central corpuscle in the first maturation of *Crepidula* and the division of the "*Nebenkörper*" in the swarm spores of *Paramœba* (Schaudinn '96).

during the cycle of division, *i. e.*, both are chromatic at one stage and plasmatic at another. I have already remarked upon the fundamental similarities between the nuclear reticulum and the centrosomal reticulum, and also upon the parallelism in the cycle of changes which both structures undergo. While therefore I recognize, together with the authors named above, the resemblance of the metazoan centrosome to the intra-nuclear spindle of the Protozoa, *i. e.*, the micro-nucleus minus the chromatin, I maintain with R. Hertwig that one need not go so far as the Protozoa to find structures homologous with the centrosome since such may be found in the formed achromatic substance of metazoan nuclei, *i. e.*, in "nuclei without chromatin" (basichromatin).

3. Spheres.—The large, densely staining sphere which persists through the whole of the resting stage in all of the gasteropods which I have studied, represents in the main the cortical zone of the attraction sphere, though remnants of the outer zone of the centrosome may be found in it after the origin of the new amphiaster. In each cell-generation the new centrosome and, perhaps, also the new cortical zone arises within the old centrosome (*cf.* figs. 25 and 70), so that the *anlagen* of both centrosomes and spheres (at least in some mitoses) come from the previous centrosome. Achromatic substance from the nucleus plus hyaloplasm from the cell body fills the cortical zone and swells it into the enormous sphere of later stages of division. After the new amphiaster appears it moves out of the old sphere, and the latter may persist for a long time as a degenerating structure.

In the eggs of all animals spheres are usually present during mitosis,[1] but they usually disappear at the close of division, and in no other case can I find any account of bodies with so compact a structure persisting throughout the whole rest, or even through the following mitosis.[2]

In spermatogenesis, however, bodies undoubtedly similar to these spheres have been described by several authors, particularly by Moore, '93, Meves, '94, '96, '98, Rawitz, '96. Meves finds in the resting spermatogonia of *Salamandra* at the end of summer that the sphere becomes a heap of granules; in the spring the sphere is reconstituted out of these granules and in the summer a "consolidated sphere" bounded by a sharp line or even a membrane is found. This sphere probably contains a centrosome at all times, though it is not always visible. The daughter centrosomes and central spindle arise within this sphere. The sphere is composed of a cortical and a medullary zone, and the former, at least, breaks up and is scattered through the cell. Masses of these granules collect close under the cell wall, and at the equator of the cell, and when the cell body divides they lie along the newly formed cell membrane. These granules are frequently present for some time in the daughter cells, but usually disappear before the next division. In all stages of this

[1] Carnoy and Lebrun ('97) totally deny the existence of spheres of any kind. They say: "Boveri's archoplasm is a part of the cell-substance; van Beneden's attraction sphere, Guignard's directive sphere, Vejdovsky's periplast, the earlier kinoplasm of Strasburger do not exist as such. These myths belong in the legends." . . Such sweeping statements are chiefly valuable as illustrating the worthlessness of dogmatic biology.

[2] Bolles Lee ('95) finds in the testis cells of *Helix* that the spindle remnants are preserved from generation to generation, the old spindle remnants fusing with the new ones.

metamorphosis the sphere substance remains distinct from the remaining cell substance and in this respect resembles the archoplasm of Boveri, though spindles are not formed out of it. It has been known variously as "sphere," "*Nebenkern*," "*Centrodeutoplasm*" (Erlanger); Meves proposes to call it *Idiozome*. It is formed from eliminated chromatin; as to its origin he says:—(Meves '94, p. 158) "Einen anderen Theil des eliminirten Chromatins, der nicht zur Bilding eines Nebenkerns verwandt wird, findet man in den Spermatogonien des Salamanders nach meiner Beschreibung in dem die Sphäre representirenden Körnerkranz; in einem bestimmten Stadium des Processes sind kleinste Chromatinkügelchen von einem Hof von Spärensubstanz umgeben." Again (p. 159):—"Später scheint das Chromatin seine Reaction zu ändern und in dem Aufbau der Sphäre mit einzugehen."

The idiozome is found particularly, perhaps exclusively, in male sexual cells, and Meves agrees with Kostanecki and Siedlecki, Erlanger, Lenhossek and Montgomery, that it cannot be homologized with the sphere of egg cells, though, perhaps, it is homologous with the yolk nuclei of ovarian eggs. Unlike the attraction sphere of van Beneden it is (1) not radiating in structure, (2) only present in resting stages, not in mitosis, (3) sharply limited from surrounding cytoplasm. In spite of these differences I make bold to say that the spheres which I have observed in gasteropod eggs are certainly homologous with Meves' idiozome. To recall only a few of the resemblances:—(1) Both arise (in part) from eliminated chromatin which changes its staining reaction. (2) Both have the same relations to the centrosomes and central spindle. (3) Both persist and preserve their individuality through the entire resting period and even into the following mitosis. (4) Both show a cortical and a medullary zone. (5) Both are sharply delimited from the cytoplasm. (6) Neither has radiating structure during the rest stage. (7) Both ultimately disintegrate and are scattered as coarse granules immediately under the cell membrane.

The sphere in these gasteropods is derived from an undoubted attraction sphere, with radial structure and without sharp demarkation from the cytoplasm. I conclude, therefore, that the term *idiozome* should be extended so as to include the spheres present in all resting cells, or that it should be abandoned altogether. Since it represents, in gasteropod eggs, merely the resting stage of the sphere, it seems to me no more entitled to a specific name than the resting nucleus.[1]

4. Archoplasm.—Of late there has been much discussion of the Archoplasm hypothesis of Boveri ('88) and the general conclusion seems to be that this hypothesis is untenable (*cf.* Heidenhain, Koštanecki, Erlanger, Wilson, R. Hertwig, Carnoy and Lebrun, *et al.*) This conclusion is based on the proposition that there is no peculiar substance such as Boveri's hypothesis supposes. Boveri ('95) himself admits that he has been unable to find archoplasm except in the eggs of *Ascaris* and in *Noctiluca*.

The principal features of Boveri's archoplasm hypothesis are the following (*cf.* Wilson, '95, p. 444): — (1) A specific substance, distinct from other cell constituents,

[1] R. Hertwig ('99) expresses the view that idiozome, spheres, centrodeutoplasm, Nebenkern, etc., are only giant centrosomes or centrospheres.

which may be scattered through the cell, or aggregated into a sphere around the centrosome. (2) In karyokinesis it divides, following the division of the centrosome, and it forms the achromatic spindle and the polar astral systems, its granules being transformed into fibres. (3) After karyokinesis its fibres are again resolved into granules which are withdrawn into the spheres. (4) It is a persistent cell element.

The many points of resemblance between this substance and the "sphere substance" of *Crepidula* must be at once apparent; the most important points of difference are that in *Crepidula* and other gasteropods this substance does not divide with the division of the centrosome and is not a self perpetuating cell element. It is a specific substance, temporarily distinct from other cell elements; it arises anew in each cell generation; it forms a part of the spindle and asters; at the close of karyokinesis it is withdrawn into a sphere surrounding the centrosome, and when the intial spindle moves out of the sphere, the latter slowly disintegrates and disappears in the general cytoplasm.

Boveri held that the archoplasm sphere was largest in the prophase and then diminished in size as rays were formed out of it. Zeigler, Kostanecki and Seidlecki find that the reverse is the case, *viz.*, that the granular mass increases as the rays increase and decreases with them. In all the gasteropods which I have studied with reference to this point, this substance is smallest in quantity at the beginning of karyokinesis and continually increases as division advances.

If regard be had to the exact definition of archoplasm which Boveri gave, then this sphere substance cannot properly be called archoplasm. However it sufficiently resembles the archoplasm in location and general characteristics to warrant the belief that it corresponds to the substance observed by Boveri, if not to his definition of that substance.

A specific substance, at least temporarily distinct from the general protoplasm of the cell has been found in astral and karyokinetic figures by almost all recent writers; *cf. Kinoplasm* (Strasburger), *Ergastoplasm* (Prenant), *Cyanoplasm* (Morgan), *Archoplasm* (Wilson, Griffin, Foot and many others). The whole appearance of a karyokinetic figure, its definite form, separation from the surrounding cytoplasm, staining reactions, all show that we are here dealing with a substance which is specifically different from the general cytoplasm. The physiological relations of the amphiaster to the cell body, no less than its morphological characteristics lead to the same conclusion. On the other hand the evidence both from observation and experiment now renders it extremely probable that this specific substance is a temporary differentiation of the cell- and nuclear-plasm which may again be transformed into the general protoplasm; in short it is not self propagating and absolutely continuous.

Those who have studied the eggs of *Ascaris* can scarcely doubt that the substance which Boveri described in that animal under the name of *Archoplasm* is homologous with the specific substance found in the astral and karyokinetic figures of many other organisms, and if this be the case it seems to me that the name given

by Boveri, or, rather, the modified form of it, viz., *Archiplasm*, which has been widely used and accepted, ought still to be applied to this substance, even though Boveri's views as to its characteristics may not be fully accepted in all cases. Fortunately it is not generally considered necessary to change the name of a thing every time we change our views as to its qualities. Neither the cell itself nor any morphological element of it means to all investigators the same thing which it meant to its discoverer, and yet we generally find it advisable to retain the old name, changing our conception of the thing named as our knowledge advances.

II.

CYTOKINESIS.

The term *Cytokinesis* (Whitman, '87, Ryder, '94, Rhumbler, '96) is here used to designate those movements within the cell body during its cycle of division which correspond to the nuclear activities during the division of the nucleus. Viewed in this light, cell division consists of karyokinesis and cytokinesis, the two being so intimately related that one cannot be treated wholly apart from the other.

These protoplasmic movements are of particular interest in that they throw light upon the constitution of the cell and the mechanics of cell division as well as upon the more complex problems of differentiation. Thus the movements in the spindle, aster and cell body during division indicate that the protoplasm is of a fluid or semi-fluid constitution, permitting freedom of movement among its parts; that these movements are in the nature of diffusion streams, as Bütschli has repeatedly maintained; and, further, that these movements are the immediate cause of many important differentiations.

Before taking up these movements in detail we shall briefly consider:

I. The Structure of the Cytoplasm.

The cytoplasm of the egg of *Crepidula* presents the appearance of being composed of alveoles, and this conception of its structure is most in consonance with the many movements within the cell which will be described later. The egg contains a large quantity of yolk in the form of spherules which vary enormously in size. The smaller yolk spherules seem to lie within the alveoles, though the larger ones of course do not. In addition to the yolk spheres which always stain intensely with iron haematoxylin, there are other small spherules which are never seen except in material fixed for a considerable period in Hermann's fluid. These spherules are about the size of the smallest yolk spheres and like them appear to lie within the alveoles, but unlike them do not stain with haematoxylin and are of a pale gray color. They may represent partially dissolved or digested yolk spheres.

With the highest powers of the microscope which I have been able to use, *viz.*, Zeiss Apochromatic Obj. 1.5 mm. Occ. 12, the karyokinetic spindles and astral rays show no indication of alveolar structure, nor indeed does the nuclear sap which forms the interfilar substance of the spindle and spheres. In the anaphase and telophase, the spheres as well as the centrosomes are alveolar or recticular. Within the cytoplasm the alveoles are smaller and their walls thicker the nearer they lie to the centrosomes (figs. 54, 55) as Bürger ('92), Eismond ('95), Rhumbler ('96) and Erlanger ('96), have shown to be the case in other forms.

In certain stages (*e. g.*, fig. 54) the walls of the alveoles are very thick and stain so deeply that I conclude that they are composed of achromatic nuclear material which has diffused from the spheres in addition to the substance of the alveolar layer (hyaloplasm) which is diffusing toward the spheres from the cell body. These radiations run between the alveoli and not through them, and in certain stages, particularly early prophases and late telophases, show a zig-zag course between alveoli or even branchings and anastomoses around them, figs. 54, 61, *et seq.* (*cf.* Wilson '99).

How to harmonize the well known fact that protoplasm behaves as a thick fluid, with those other well established facts as to its differentiations and the localization of differentiated structures within it, is a problem to which much attention has been paid. Long ago Brücke ('61) pointed out the fact that a definite organization could not exist in a fluid and that a fluid plasma would be incapable of performing the complex functions of the cell. Since that time the further study of the cell has but emphasized the great complexity of its structure and functions, and this has led many authors to regard the cell as a relatively stable system of parts, the interstices between which are filled with a fluid-like substance. On the other hand the continued study of living protoplasm has more fully demonstrated its fluid character; the freedom with which parts may move about within cells, particularly in certain Protozoa and in metazoan egg cells, is entirely inconsistent with the idea that the cell is traversed by a fixed system of fibres which bind all its parts into a stable system. Bütschli's theory of the structure of protoplasm is the only one which undertakes to harmonize these apparently contradictory phenomena, for while emphasizing the fluid character of protoplasm it still assigns to it a definite structure and provides for the local differentiations and specific organization of the cell (*cf.* Bütschli '92, Rhumbler '98). I accept without reserve the Bütschli theory so far as it concerns the general cytoplasm of the eggs which I have studied, but I have seen no sufficient evidence that it extends to all the parts of the cell.

II. Movements of Cell Contents.[1]

In the maturation, fertilization and cleavage of the gasteropod eggs which I have studied I have observed successive stages of a complex and orderly movement of the entire cell substance by which the positions of the cytoplasm, yolk, nuclei, centrosomes, spheres and mid-bodies (*Zwischenkörpen*) are changed in a definite and orderly way. Unfortunately, I have been unable to actually observe these movements in the living egg, since the eggs studied contain a large amount of yolk and are therefore opaque, and since the movements described are very slow. However, the evidences of these movements are so abundant and unmistakable that one could not be more certain of them if he had seen the actual flowing of the cell substance.

[1] A portion of this section was published in the *Wood's Holl Biological Lectures for 1898.* (Boston, 1899).

A. Movements during Maturation.

First Maturation.—The cell movements during maturation result in the segregation of yolk and cytoplasm at opposite poles of the egg, and in the transportation of the mitotic figure to the animal pole. While the germinal vesicle is still intact it lies some distance from the periphery and is closely surrounded by yolk spherules, and there is a very incomplete separation of yolk and cytoplasm throughout the entire egg. As soon as the mitotic spindle is formed and the nuclear membrane is broken, there is an area immediately surrounding the spindle and asters free from yolk, but elsewhere in the egg there is an intimate mingling of yolk and cytoplasm. The initial position of the spindle differs in different eggs; it rarely lies in the chief axis of the egg and may be at right angles to this. Gradually the spindle turns until its axis nearly coincides with that of the egg, and at the same time the whole spindle is moved out toward the surface, until finally the outer end of the spindle comes into contact with the cell membrane, and the surface of the egg is elevated into a papilla at this point. This movement is in part due to the mere lengthening of the nuclear spindle which doubles in length during the process, but in part also to a general movement of the cell substance by which the spindle is turned and carried bodily toward the surface of the egg. At the same time there are movements within the egg which lead to an accumulation of cytoplasm at the animal pole and a movement of the yolk spherules toward the opposite pole. There is no evidence that this movement is due to activity on the part of the nucleus and centrosomes. The initial position of the centrosomes and the direction of the central spindle are not the same in different eggs, and yet the final position of the mitotic figure is the same in all cases; the centrosomes and asters at the two poles are identical in form, size and staining reactions until the outer pole of the spindle comes into contact with the surface of the egg. When this occurs the sphere and centrosome at the outer pole become flattened against the egg membrane (Pl. I, figs. 14, 15). At the same time the spindle begins to shorten, and this continues until it is not more than half as long as in the metaphase or early anaphase. At the same time the chromosomes at the outer pole are crowded into the sphere (fig. 16), and finally they are pushed through this until they come into contact with the opposite cell wall (figs. 22, 23). Such a phenomenon is found only in the formation of the polar bodies and must be caused by factors which are wholly different from those which have commonly been held to be active in the mechanics of mitosis. Neither the contraction of mantle fibres (Van Beneden, Boveri), nor the growth of central spindle fibres (Drüner), nor the chemotropic influence of the centrosome and sphere (Strasburger) will explain the extreme movement of the chromosomes in the first maturation. On the other hand the evidence is conclusive that this extreme movement of the chromosomes is due to the same factor which forces the entire spindle into contact with the egg membrane and then causes the flattening of the sphere and centrosome and the shortening of the spindle. Evidently this factor lies wholly outside of the spindle, since it acts upon the spindle as a whole, and must consist of stresses

in the cytoplasm, probably of active movements, and the fact that throughout the egg the separation of yolk and cytoplasm is going on at this time is additional evidence in favor of such general movements in the cell body.[1]

Second Maturation.—The initial position of the second maturation spindle varies greatly in different eggs; in some cases it is almost at right angles to the egg axis (*e.g.*, fig. 28), but it always turns so that one pole lies almost in contact with the mid-body between the egg and the first polar body. It is very probable that the spindle turns into the line of least resistance, and the fact that the line of least resistance leads directly from the chromosomes to the mid-body may be due to the persistence in this axis of the spindle remnants of the first maturation. The second polar body is extruded immediately under the first, so that the latter is raised upon the former and is separated from the egg. This also must be due to the fact that the surface tension is least at this point. Whether this is the result of the fact that the egg membrane is here lifted by the first polar body, or that the surface layer between the egg and the first polar body is here newly formed, or that the cell membrane grows most rapidly over the pole of the spindle cannot be determined by observation alone.

B. Movements during Fertilization.

During the fertilization similar movements of the egg contents are apparently taking place; the polar segregation of yolk and cytoplasm goes on during the approach of the germ nuclei, and, as during maturation, appears to be due to movements of the cytoplasm. The spermatozoon usually enters near the vegetal pole, and is carried through almost the whole diameter of the egg to the animal pole, but it may enter at any place except the protoplasmic area immediately around the animal pole. If the sperm enters at the vegetal pole, its course toward the animal pole is nearly straight; if it enters elsewhere, its course is curved, and the nearer the point of entry to the animal pole the greater the curvature.

The egg nucleus and aster lie very near the animal pole and do not move from this position; they are surrounded by an area of protoplasm free from yolk. The sperm nucleus and aster in their advance through the yolk leave no path behind them; either they are carried along by a general movement of the cell contents, or the yolk is pushed out of their way, to close in again behind them immediately after they have passed. The germ nuclei and asters approach each other, and when the two are close together they lie in an area entirely free from yolk, except that a few spherules are usually found between the two nuclei or asters. These spherules, which are separated from all the rest of the yolk, appear to have been carried before the sperm elements in their advance. After the origin of the cleavage centrosomes the remnants of the asters are carried to a point above the nuclei and immediately under the polar bodies, where they disintegrate and are scattered

[1] Kostanecki and Wierzejsky ('96) have observed in *Physa* that the peripheral movement of the spindle, and the separation of the yolk and cytoplasm go hand in hand.

as coarse granules—a process which will be described more fully when we come to consider the cleavage.[1]

What brings the germ nuclei and asters together? In a former paper ('94) I suggested that the nuclei were passively drawn together by the formation, attachment, and contraction of astral rays, and Kostanecki and Wierzejski ('95) afterward advanced this same view. They maintain that astral rays are strongest while the germ nuclei are being brought together and that as soon as this is accomplished the rays are functionless and disappear. Wilson ('96) regards this view as untenable, and concludes that "the nuclei are drawn together by an actual attraction which is neutralized by union, and their movements are not improbably of a chemotactic character." Morgan ('96) also rejects this idea, and I have myself ('99) practically abandoned it. Nevertheless, unless the nuclei are actively locomotive it must still be true that they are brought together by something outside themselves. This something must of necessity be found in the cytoplasm (including the aster), unless the nuclei are able of themselves to move actively. There is every evidence that the nuclei in this, as in most other cases of movement, are passive, and that their movements are brought about by the activity of the cytoplasm.

The migration of the sperm nucleus, like that of the maturation spindles, is accompanied by progressive separation of yolk and cytoplasm, and it is probable that these coincident phenomena have a common cause in general movements of the cytoplasm.

Furthermore, there are certain elements of constancy in the polar differentiation and in the plane of the first cleavage which cannot be attributed to the nuclei, and, so far as I can see, can be due only to definite characters of the cell body. It is the egg cell rather than the nucleus which shows polar differentiation. The sperm nucleus and aster approach the animal pole from various positions; there is great variation in all the positions of the nuclei and asters relative to each other, and yet there is no variation in the plane of the first cleavage which always passes through the point of extrusion of the polar bodies, and in cases where the first cleavage is unequal the mitotic figure is always eccentric to the same degree. Now the first cleavage, as we shall see, is accompanied by extensive rotary movements of the cell contents, and this fact, joined to the evidences of cytoplasmic movement during maturation and fertilization, leads me to believe that definite movements of cell substance exist in the unsegmented egg. The constancy of cleavage in later stages is associated with constancy of movements in the cytoplasm, and it is probable that the same is true of the constancy which precedes cleavage.

[1] A lobe of cytoplasm appears at the vegetal pole just before the germ nuclei meet, fig. 77. It persists during the first and second cleavages, being nearly separated from the egg during each division of the cell body, fig. 80. It never divides with the cleavage of the egg, but always remains attached to one of the daughter cells, and is gradually resorbed into that cell at the close of the cleavage, fig. 81. This lobe is probably homologous with the "yolk lobe" of *Chaetopterus* (Mead), of *Illyonassa* (Crampton), of *Fulgur* (McMurrich), and of the following gasteropods which I have examined; *Urosalpinx, Nassa, Sycotypus* and four species of *Crepidula*. In all the species of *Crepidula* it contains no yolk and is very small; in *Sycotypus* and *Fulgur* it is larger than in *Crepidula* and contains some yolk, but is still relatively small; in *Illyonassa, Nassa* and *Urosalpinx* it is very large and is filled with yolk.

That the movements within the cell substance of the unsegmented egg are, in certain cases at least, of a vortical character is indicated by spiral asters, first described by Mark for *Limax*, and since observed by several investigators in other animals, and also by my observation that the first cleavage in *Crepidula* is a spiral one, being oblique to the right, or dexiotropic, (see p. 80, also Conklin '97).

C. Movements During Cleavage.

It is, however, in the cleavage of the egg that I have found the most unmistakable evidences of definite and orderly movements of the cell contents. These movements occur before, during and after the division of the nucleus, and are thus characteristic of the entire cycle of division. Since the different cleavages differ considerably in the character and extent of these movements it will be necessary to devote some attention to each cleavage.

The entire history of these movements could never be determined by means of sections alone, though these are of great supplementary value, but recourse must be had to preparations of entire eggs. In such eggs, prepared in the manner specified on page 6, the whole course of these movements can be followed with great clearness and the relative positions of spheres, centrosomes, nuclei and mid-bodies can be accurately determined at every stage.

(1). *First Cleavage.*—At the beginning of this cleavage the cytoplasm is well separated from the yolk in the region of the germ nuclei. Above the nuclei and below the polar bodies traces of the egg and sperm spheres may still be seen, figs. 78, 79. As the spindle elongates and the astral radiations extend, the cytoplasmic area first elongates and then the entire egg becomes ellipsoidal.

From the prophase to the anaphase the mitotic figure lies in a cytoplasmic area almost entirely free from yolk and there are few, if any, yolk spheres between the spindle and the polar bodies, figs. 55, 57, 58 (in the preparation from which figs. 57 and 58 were made, the polar bodies were attached as in figs. 59–61, but in order to save space on the plate the upper parts of the figures, showing the polar bodies, were cut off from the drawings). In the late anaphase, however, the yolk spheres are present not only in the superficial layer of protoplasm, but also in a plane running right through the middle of the spindle, figs. 59, 60, 66, 67; in fact the only area free from yolk spheres at this stage is that immediately surrounding each of the asters. This position of the yolk can have been caused only by extensive movements of the cell substance, the yolk being carried up at the periphery toward the animal pole and then down through the middle of the egg in a plane at right angles to the axis of the spindle (*cf.* figs. 55–61, 80, 81). While this movement is most easily seen and is probably strongest in the direction indicated, *i. e.*, up at the periphery toward the animal pole and then down through the plane of the first cleavage, yet the constriction which forms all around the egg (see fig. 80) shows that the movement must be from the whole equatorial periphery toward the spindle axis. However, this constriction is deepest on the side of the animal pole where this movement is most evident.

Until the anaphase of this cleavage the spindle axis is a straight line, figs. 59, 66. In the telophase the mid-body, which marks the middle of the spindle, is carried down toward the vegetal pole, while the centrosomes, spheres and nuclei are moved up nearly to the animal pole, fig. 60. Finally, in the resting stage the centrosomes and spheres lie almost beneath the polar bodies, the nuclei lie just below these, while the mid-body lies a little below the middle of the plane of contact between the two daughter cells, fig. 61. In short, the spindle axis which was a single straight line up to the anaphase, becomes bent on itself in the telophase and in the resting period until its two halves lie close to each other on opposite sides of the new cell wall.

These movements of the structures which lie in the spindle axis are accompanied by general movements of the cell contents in the same direction. Thus the cytoplasm which is at first spread out in the form of a cap at the animal pole, grows deeper in the telophase, and is carried down with the mid-body to the middle of the cleavage plane; at the same time the yolk is carried up at the periphery toward the animal pole, figs. 61, 79, 80, 81.

The movements in the first two cleavage cells are not, however, directly at right angles to the plane of the first cleavage, but viewed from the animal pole they are slightly dexiotropic, as is shown by the fact that the nuclei, spheres, and protoplasmic areas all move in a dexiotropic direction (fig. 82 and text fig. VIII). The remains of the spheres of the first cleavage can be seen, until the anaphase of the second cleavage, lying near the upper surface of the two blastomeres and close to the wall between them, figs. 83 and 84; in this position they gradually fade out into the cytoplasm, until at the close of the second cleavage no trace of them can be seen. The rotation of cell substance indicated in fig. 82 continues until the superficial extent of the protoplasmic area is smaller and its depth greater than is indicated in that figure, and until the new centrosomes have taken their positions at the poles of the greatly inflated nuclei.

Such a change in the position of these parts could be brought about only by a general rotation of the entire cell body. This general rotation precedes, accompanies and follows the movements of the nuclei, centrosomes and spheres (*cf.* figs. 59, 60, 61), and is, in all probability, the cause of these movements.

(2). *Second Cleavage.*—At the close of the first cleavage the centrosomes lie above and on the outer side of the nuclei (*i. e.*, on the side away from the polar bodies), figs. 82, 83. Here the centrosomes elongate and give rise to the daughter centrosomes and central spindles, which stretch across the nuclei in the groove between the two germ halves, fig. 83, text fig. VIII, while the remnants of the spheres move into the furrow close under the polar bodies. In this position the definitive spindles are formed, while the outlines of the vesicular nuclei, still filled with nuclear sap, are visible on the side of the spindle next the polar bodies even as late as the metakinesis, fig. 84. With the exception of the centrosomes and asters the entire mitotic figure is lodged within that portion of the vesicular nucleus farthest removed from the first cleavage plane, and into the spindle, thus located, all the chromo-

somes are drawn, leaving only the darkly staining nuclear sap in the remaining portion of the mother nucleus, fig. 84.

At this time the nuclei and cytoplasmic areas still preserve their dexiotropic positions in each cell, fig. 83, text fig. VIII; with the breaking of the nuclear membrane, however, the spindles and cytoplasmic areas shift into a læotropic position, fig. 84, and at the same time the surface extent of the cytoplasm becomes greater, and the blastomeres, which had become so flattened against each other that they were nearly perfect hemispheres, again become more and more spherical in shape. The spindles, cytoplasm and entire cell then elongate in the direction of the spindle axis; a constriction appears first at the animal pole and then entirely around the periphery in the equator, and the cell divides as in the preceding cleavage.[1]

In the telophase of the second cleavage the nuclei, spheres and centrosomes again move toward the animal pole while the middle of the spindle and the mid-body are carried down and away from the animal pole toward the middle of each cleavage plane, fig. 86. The direction of this rotation is læotropic in the two blastomeres which lie at the higher level (A and C, fig. 86) and dexiotropic in the two lower ones (B and D, fig. 86). This movement continues until the centrosomes and spheres are carried into the inner angles of the cells, immediately below the polar bodies and until the daughter nuclei, which at first lie very near each other on opposite sides of the second cleavage planes, fig. 86, are swung out into the centers of the cytoplasmic areas, fig. 87.

(3) *Third Cleavage.*—The centrosomes and central spindles then appear as in the preceding cleavage, *viz.*: on the upper and outer sides of the nuclei and in the grooves between the germ halves, figs. 70, 71, 88. The spindles do not at first occupy similar positions in the four cell, but are often dexiotropic in the two lower blastomeres (the ones meeting in the polar furrow) and frequently læotropic in the upper ones, fig. 88. As the cleavage advances, however, the spindles are all turned into a dexiotropic direction. All this time the remains of the spheres of the preceding cleavage occupy the central angles of the cells, and when the upper pole of the spindle moves up under them, their substance is spread in the form of a ring with dense periphery and clear center, figs. 87–90 and text figs. XIX–XX. The spindle and cytoplasm, then elongate, as in the preceding cleavages, and although the cell as a whole does not elongate symmetrically, *i. e.*, at the two poles, it does elongate by the formation of a lobe of protoplasm over the upper end of each spindle. This lobe becomes more and more prominent, and into it the upper pole of the spindle moves. Then the equatorial constriction of the cell begins, forming all the

[1] The equatorial constriction sometimes appears as a broad irregular depression in the cytoplasm beneath the polar bodies (fig. 85). At the margins of this depression there may be serrated processes of cytoplasm which project for a short distance over the depression. I have seen this phenomenon in only a few eggs, and do not know whether it is a normal one or not. It reminds one of the threads and "filose processes" observed by G. F. and E. A. Andrews ('97, '98) in various forms of protoplasm. In this same preparation (fig. 85) the cytoplasm adjoining the first cleavage on each side of this depression is elevated into a ridge; it looks as if the formation of the depression and the elevation of the ridge were parts of the same process.

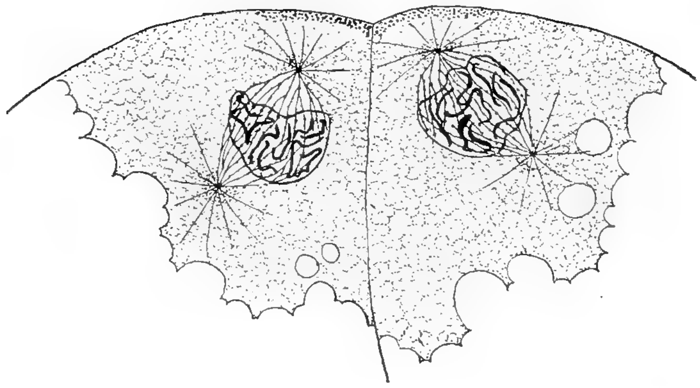

Fig. XIX.

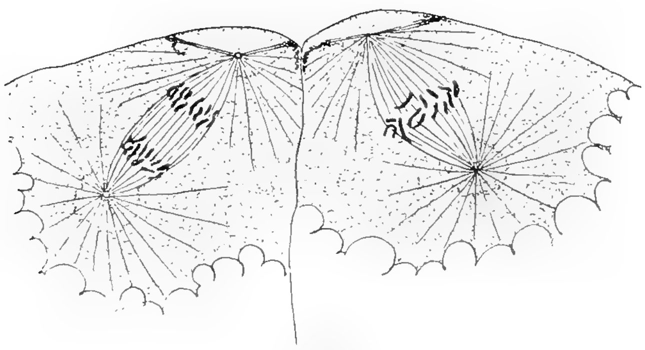

Fig. XX.

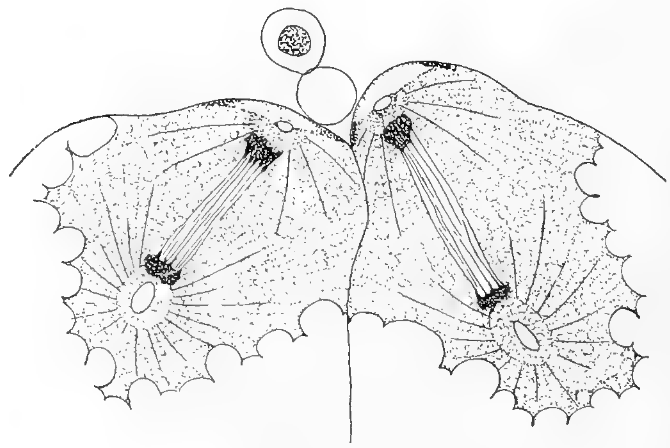

Fig. XXI.

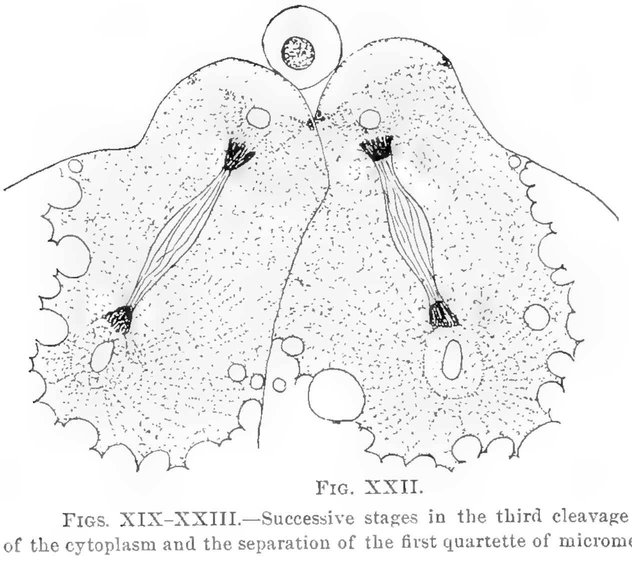

Fig. XXII.

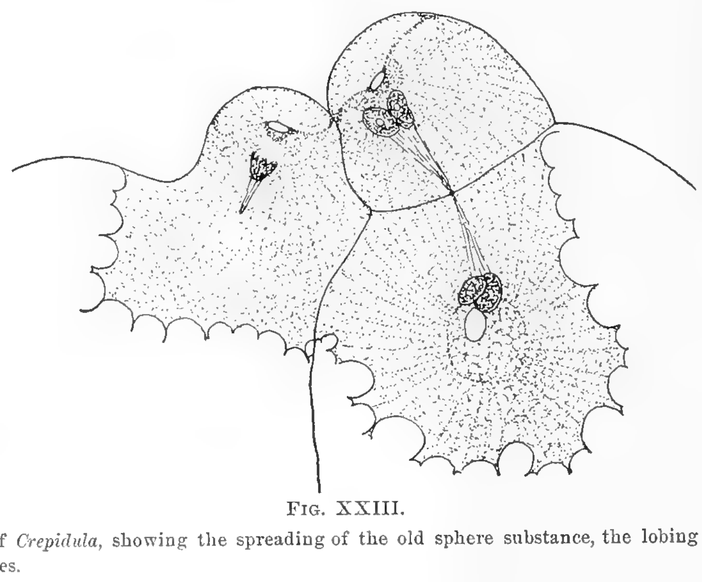

Fig. XXIII.

Figs. XIX–XXIII.—Successive stages in the third cleavage of *Crepidula*, showing the spreading of the old sphere substance, the lobing of the cytoplasm and the separation of the first quartette of micromeres.

way around the periphery as in the preceding cleavages, and ultimately separating the first group of micromeres from the macromeres, fig. 90 and text figs. XXI–XXIII.

In this division there is a differential distribution of the sphere substance, the whole of the sphere remnants of the preceding division passing into the micromeres while no portion of them goes into the macromeres. During division each cell becomes more nearly spherical than in the resting period, and especially in the late anaphase, when the equatorial constriction is occurring, the daughter cells (both macromeres and micromeres) are so nearly spherical that they touch neighboring cells only by relatively small surfaces, fig. 90. In the telophase and rest they again flatten against one another, fig. 91.

During the telophase of this cleavage the cell contents rotate in a dexiotropic direction in the upper cells (micromeres), and in a læotropic direction in the lower cells (macromeres). Even before the telophase this movement is presaged by the dexiotropic lobing of the cytoplasm in each cell preparatory to the formation of the micromeres; in the telophase it appears in the bending of the spindle axis and in the rotation of the nuclei, centrosomes and spheres. In fig. 90 the earliest bend in the spindle axis is indicated, the middle of the spindle in three of the cells being displaced slightly to the right. Sections through an egg of this stage show that the spindle axes are also bent at the middle toward the surface of the egg, fig. 73. The dexiotropic rotation of the substance of the micromeres continues until the daughter nuclei are carried from the left to the right sides of the cells, though the spheres being in the angles of the cells nearest the animal pole are unable to move through any considerable arc (*cf.* figs. 90, 91). At the same time the substance of the macromeres rotates to the left, until the nuclei, centrosomes, spheres and cytoplasmic areas are carried to the extreme left sides of these cells. Throughout the whole of this movement the centrosomes and spheres never move under the cells of the first quartette, but they always lie on the outer margin of these cells and in contact with a free surface of the macromeres, fig. 91; the nuclei on the other hand are partially or wholly overlaid by the micromeres.

(4). *Fourth Cleavage.*—In this position the centrosomes and central spindles for the fourth cleavage of the macromeres arise from the mother centrosomes, the spindles lying over the upper and outer portions of the nuclei and in the groove between the germ halves as in the preceding cleavages, figs. 74, 75, 91, 92. The initial position of these spindles is very different from their final position; at first their axes are nearly at right angles to planes bisecting each macromere in a radial direction, and the two poles of each spindle are at nearly the same horizontal level. Then the left pole of each spindle rises until it lies immediately under the remnants of the sphere at the surface of the macromere, while the right pole sinks towards the center of each macromere. When the left pole of the spindle approaches the old sphere substance the latter is spread into a ring with dense periphery and clear center, fig. 92, text figs. XXIV, XXV, XXIX, as in the preceding cleavage. Then the cell elongates in the direction of the spindle axis by the formation of a lobe of cytoplasm in the region of the old sphere substance, and at the same time the spin-

dle axis shifts through an angle of about 45°, the upper pole of the spindle being carried in toward the animal pole until the lobe of cytoplasm is pressed into the angle between contiguous cells of the first quartette, fig. 93. In this position the "equatorial" constriction occurs and the second quartette of micromeres is separated from the macromeres.

As the whole of the sphere substance of the second cleavage goes into the first quartette of micromeres, so all the sphere substance of the third cleavage, remaining in the macromeres, goes into the second quartette where it rapidly disappears.

In the telophase the cell contents of the second quartette move in a læotropic direction until the centrosomes and spheres are carried from the extreme left to the extreme right of each cell; at the same time the entire cell contents of the macromeres move in a dexiotropic direction until the nuclei, centrosomes, spheres and

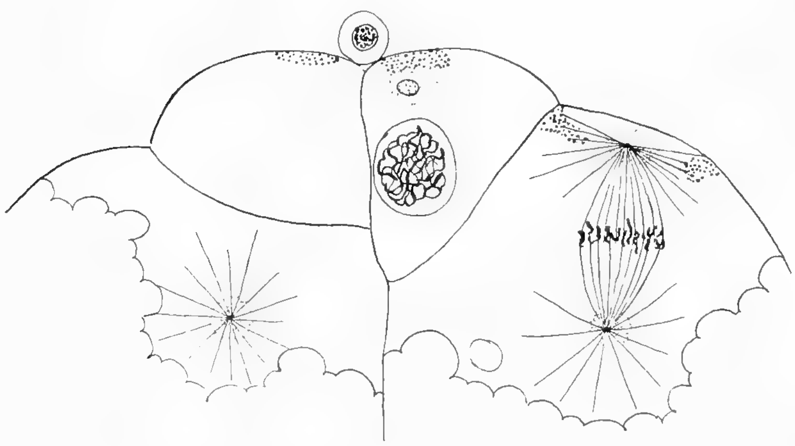

FIG. XXIV.

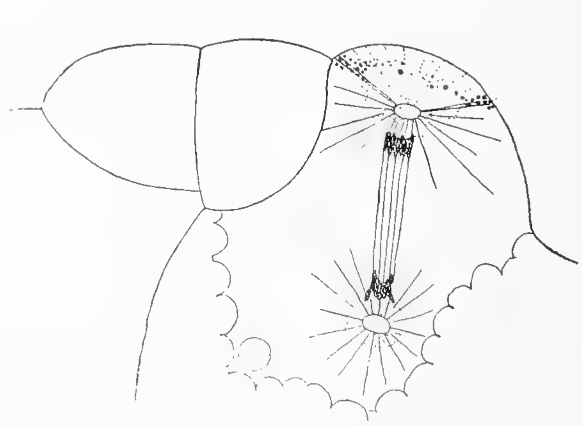

FIG. XXV.

FIGS. XXIV, XXV.—Two stages in fourth cleavage of *Crepidula* showing the spreading of the old sphere substance at the upper pole of the spindle and the lobing of the cytoplasm to form the second quartette of micromeres.

cytoplasmic areas are carried to the right side of each cell (*cf.* figs. 93, 94, 95, text figs. XIII, XIV). As a consequence of these movements in the daughter cells, the spindle axes which were straight lines, until the telophase become bent at the mid-bodies until finally the two halves of each spindle are nearly parallel with each other. This movement of the cell contents and consequent bending of the spindle axes is greater in the second quartette cells than in the macromeres, the rotation in the former being through an angle of more than 90°.

During these movements and throughout the succeeding rest period the centrosomes and spheres are never overlaid by other cells; both in the second quartette and in the macromeres they lie as near as possible to the animal pole without moving under the first quartette cells, fig. 94, 95. If in some cases (*e.g.* fig. 95) they seem to be covered by the cells lying nearer the animal pole, this is due merely to the overarching of these cells, as side views and sections show. In all cases the centrosomes and spheres lie next to free surfaces of the cells.

(5). *Fifth and Sixth Cleavages of the Macromeres.*—While the cell contents of the macromeres are moving from the left to the right side of each cell, the

daughter centrosomes and central spindles again arise from the mother centrosomes and these initial spindles stretch across the outer and upper side of each nucleus in the groove between the germ halves as in the preceding cleavages. The dexiotropic movement of the substance of the macromeres continues until the right pole of each spindle is brought close to the right side of each macromere and into the angle between two adjacent cells of the second quartette. Here the sphere material is spread in a ring as in the preceding cleavages, and a lobe of cytoplasm is formed over the upper pole of each spindle, text fig. XXXI. These lobes are then constricted from the macromeres, thus forming the third quartette of micromeres, fig. 96. Here, as in the preceding cleavages, the whole of the sphere substance left in the macromeres goes into the upper cell products, *i.e.*, in this case, into the third quartette. In the telophase the contents of the third quartette cells rotate in a dexiotropic direction, while those of the macromeres rotate in a læotropic direction (*cf.* figs. 96, 97, 98); the extent of these rotations, however, is not so great as in the preceding cleavages. During these movements in the telophase the centrosomes and spheres never move under the cells lying nearer the animal pole, but always remain at the margin of these cells and in contact with the free surface of the cells in which they lie, figs. 97, 98 and text figs. XV, XVI.

At the sixth cleavage one of the macromeres, D, divides much earlier than the others, and gives rise to the mesentoblast cell, 4d, figs. 97, 98 and text fig. XVI. The centrosomes and central spindle arise from the mother centrosome on the outer and upper side of the nucleus of macromere D, and it is probable that the central spindle lies in the groove between the germ halves, since this groove is plainly apparent in the daughter nuclei at the close of this cleavage (text fig. XVI), showing that the germ halves have been divided, as in all the preceding cleavages. As soon as the nuclear membrane has dissolved at the poles of this spindle the entire macromere becomes rounded and stands out from the other macromeres, being in contact with them by relatively small pressure surfaces. The spindle then becomes nearly vertical in the macromere, its upper pole being inclined slightly to the left. The upper pole of the spindle lies near the surface while the lower pole is near the middle of the macromere. Then a large lobe forms at the upper pole, extending under the micromeres as far as the polar furrow. This lobe contains not only all the cytoplasmic area and sphere substance of the blastomere D, but also a large amount of yolk, text fig. XVI. This lobe then constricts off from the macromere, forming the mesentoblast cell, 4d. This cell is larger than any of the micromeres, and is so covered by them that I have been unable to observe all the movements of its cell contents in the same satisfactory way which is possible in the micromeres. It it certain, however, that its cytoplasmic portion, containing the nucleus, centrosome and sphere, turns in a læotropic direction until these parts are carried under the micromeres and to that part of the cell which lies nearest the animal pole. After this the mesentoblast divides equally into right and left halves as shown in fig. 99, and at the close of this division the nuclei, centrosomes and spheres again rotate through an angle of 90° until they come to lie in those portions

of the daughter cells nearest the animal pole, fig. 100. While these movements are taking place in the mesentoblast and its daughter cells, the substance of macromere D rotates slightly to the right; the nucleus and sphere lie deep in the yolk, by which they are closely surrounded, text fig. XVI. In 4d and its derivatives the spheres are not in contact with a free surface of the cell during the resting period, and in these cells they become very indistinct and can only be clearly recognized during the telophase.

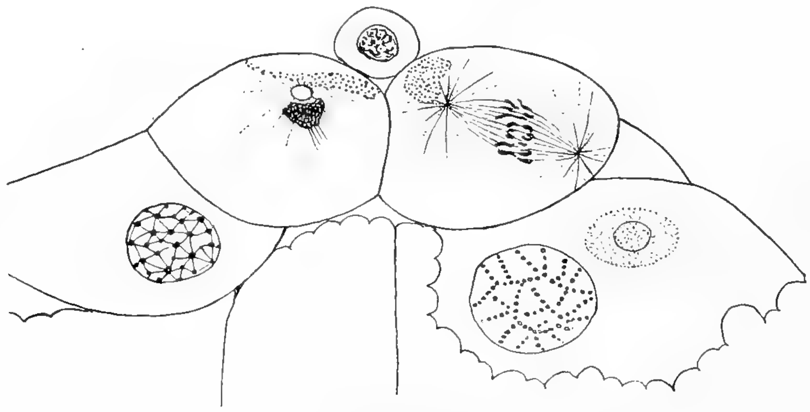

FIG. XXVI.

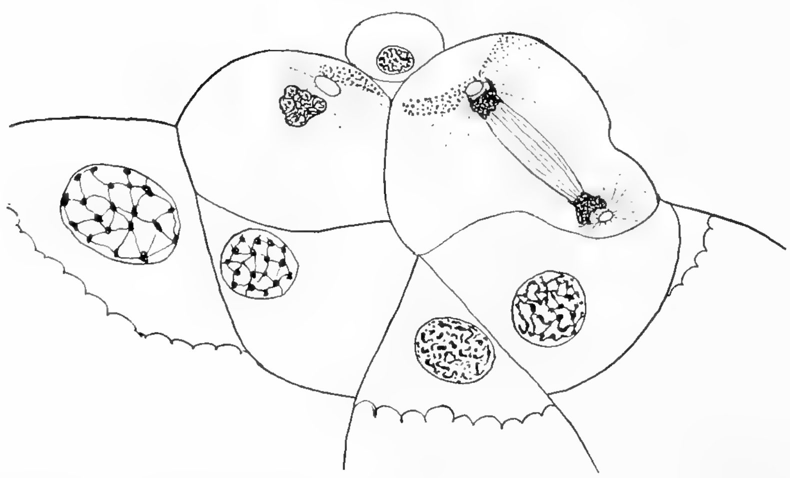

FIG. XXVII.

FIGS. XXVI–XXVII.—Two stages in the first division of the first quartette of *Crepidula*, showing the eccentric position of the spindles and the approaching unequal division of the cells.

(6). *Sub-divisions of the First Quartette.*—During and after the formation of the first quartette, the rotations in these cells are dexiotropic. When the nuclei have been carried from the left to the right side of each cell (figs. 90, 91), they are then moved close into the inner angles of the cells (figs. 92, 93). Immediately over the nuclei are the centrosomes and spheres; the former are already spindle shaped, figs. 91–93, and their long axes nearly coincide with the definitive spindle axes. The central spindles then stretch over the upper sides of the nuclei, very

probably in the groove between the germ halves (*cf.* figs. 76, 92, 93). As soon as the nuclear membrane is broken the entire mitotic figure moves out from the animal pole towards the periphery of the cell; during this movement the sphere substance remains in its former position close to the animal pole. This peripheral movement of the spindle continues until its outer pole comes almost into contact with the cell wall, while the inner pole lies nearer the middle of the cell, fig. 94, text figs. XXVI, XXVII. This position of the spindle is a perfectly definite one; the outer pole of the spindle lies near the middle of the oblique wall between the first and second quartettes, and the spindle axis is parallel with the wall between contiguous cells of the first quartette, figs. 94, 95. Although the spindle nearly doubles in length from the metaphase to the late anaphase, the inner pole remains fixed in position, while the outer pole is pushed further and further into the pointed extremity of the cell, fig. 95. During this elongation of the spindle the cell body also elongates in the same axis, and the equatorial constriction appears and cuts off a small peripheral cell from a large apical one; the small cells are the *trochoblasts*, the large ones the *cephaloblasts*. One of the first quartette cells (1d) is slightly smaller than the other three, fig. 94; it divides a little later than the others, and the cephaloblast to which it gives rise is smaller than the others, though the trochoblasts are all of the same size, fig. 96. This cleavage is a particularly interesting one since it represents a very unequal division of an apparently homogeneous cell. In this case the eccentricity of the spindle would appear to be the immediate cause of the unequal cleavage; this eccentricity is the result of movements in the cell, which begin coincidently with the breaking of the nuclear membrane.

This cleavage is a læotropic one, and in the telophase the contents of the cephaloblasts rotote in a læotropic direction, while those of the trochoblasts rotate in a dexiotropic direction, the middle of the spindle in each cell being carried to the left, text fig. XIV. In the cephaloblasts the nuclei centrosomes and spheres lie nearer the middle of these cells than in the preceding rest stage.

In this position the centrosomes and central spindles for the second division of the first quartette cells arise, as in all the preceding cleavages. The spindles and cell bodies elongate, and the equatorial constrictions occur as is usual. This cleavage is dexiotropic, the spindle axes being at right angles to those of the preceding cleavage (*cf.* figs. 95 and 97). It is also unequal, but in this case the outer products are larger than the inner ones, whereas the reverse was the case in the preceding cleavage. These larger outer products are the *basal* cells in the arms of the ectodermal cross, while the inner ones are the *apical* cells. One of the cephaloblasts, 1d (fig. 97) is smaller than the other three, and its division is not so unequal as that of the others. Accordingly, the basal cell in the arm of the cross in this quadrant, $1d^{1.2}$ (figs. 98, 99), is not so large as the other basal cells; all the apical cells are approximately equal in size. The sphere substance left in the cephaloblasts, at the close of the preceding cleavage, passes at this division into the apicals, where it rapidly disintegrates, fig. 97.

The inequality of this cleavage can scarcely be due to the eccentricity of the

spindles, as a study of fig. 97 will show. The spindles here lie very nearly in the middle of the cells, but the equatorial constrictions show plainly not only that the division will be unequal, but also that the basal cell in the posterior arm of the cross will be smaller than the other three. The cause of the inequality of this division probably lies, not in the position of the spindle, but in the activities of the cytoplasm; and this suggests that the inequality of the preceding cleavage was not caused by the eccentric position of the spindles, but that both the position of the spindles and the inequality of the cleavage are the results of cytoplasmic activities.

In the telophase of this cleavage the nuclei remain near the middle of the daughter cells, but the spheres in the apicals rotate through an angle of from 90° to 180°. In fig. 98 the spheres in these cells are close to the new cell wall between the daughter cells, *i. e.*, they have rotated over the nuclei into this new position, and, therefore, away from the animal pole; that this movement is not merely in a vertical plane is shown by the position of the spheres in fig. 99, where it is evident that the rotation is also dexiotropic, as it should be, since these cells were formed by a dexiotropic cleavage. In the basal cells the spheres move toward the free surface of the cell and a little to the left, figs. 98, 99, but this movement is never extensive; in no case do the spheres move to that portion of the cell which is nearest the animal pole, but they invariably remain on the side of the nucleus farthest removed from that pole. In both of the daughter cells of this cleavage, therefore, the movements are very unusual since the spheres do not move in the telophase as close as possible to the animal pole. The middle of the spindle axis is bent to the right, as it should be following a dexiotropic cleavage (see text fig. XVI).

Especial interest attaches to the cell movements in reversed cleavage or cases in which two successive divisions are in the same direction. Such an instance occurs in the first division of the basal cells of the cross. These cells were formed by dexiotropic division of the cephaloblasts, and to preserve the law of alternation they should divide in a læotropic direction, but they all divide dexiotropically, though the posterior and smaller one does not divide until long after the others (it is still undivided in fig. 100). The reversed cleavage of these cells is associated with the fact that during the preceding rest the centrosomes and spheres remain on the outer sides of the nuclei and do not move to that portion of the cell nearest the animal pole, fig. 99. Therefore the reversal is due to the limited extent of the cell movements, and not to reversed rotations of the cell contents.

At the close of this division of the basals the contents of the upper cells rotate to the right, while those of the lower cells rotate to the left, fig. 100. This is the typical cell movement following a dexiotropic cleavage, and accordingly we may expect to find the subsequent cleavage of these cells entirely typical, an expectation which is fully realized.

(7). *Sub-divisions of the Second Quartette.*—The second quartette cells were formed by a læotropic cleavage, and consequently the rotation within them is in a læotropic direction; this rotation has been fully described on p. 84. When this

læotropic movement has carried the centrosomes and spheres from the extreme left to the extreme right of each cell, fig. 96, the cleavage begins. The mother centrosome becomes spindle shaped and gives rise to the daughter centrosomes and central spindle. These stretch over the outer and upper sides of the nuclei, most probably in the groove between the germ halves. The right and upper pole of the spindle lies immediately under the old sphere substance, all of which goes into the right daughter cell, where it rapidly disintegrates and disappears, fig. 96, text fig. XXXI. The cell elongates in the spindle axis and the equatorial constriction appears as usual; the division is approximately equal, though the right cell product slightly overlaps the left, and therefore appears larger in surface view, fig. 97.

In the telophase of this division the contents of the daughter cells rotate, as is usual, in opposite directions, the upper or right hand cells to the right, the lower ones to the left. This movement continues until the centrosomes and spheres are carried to that part of each cell nearest the animal pole, and until the mid-body is carried downward and outward between the daughter cells, figs. 97, 98, text fig. XV. This rotation is greater in the left cells than in the right ones, owing to the fact that the latter are partly covered by the basal cells under which the centrosomes and spheres do not move; in the posterior quadrant the basal cell is smaller than the other three and does not overlap the second quartette cells to the same extent, and correspondingly the centrosomes and spheres in the second quartette cells of this quadrant are free to move to the apical side of each nucleus, figs. 97, 98.

In the second division of the second quartette cells the left hand cells divide nearly equally into upper and lower products, and the right hand cells divide very unequally, the upper products being the small *tip* cells of the arms of the cross, figs. 99, 100. The posterior tip cell is larger than the other three, and this is probably associated with the fact that the adjoining basal cell is smaller than in the other quadrants and does not overlap the second quartette cells to the same extent, fig. 100. The divisions in both the right and left cells are læotropic in direction, and in both the sphere substance of the mother cells passes into the uppermost of the daughter cells. The movements of the contents of these daughter cells in the telokinesis are in all respects typical, *i. e.*, they are læotropic in the upper products and dexiotropic in the lower ones.

(8). *Sub-division of the Third Quartette.*—The third quartette divides relatively late, and only the first division of these cells will be described here. This division is peculiar, because one of the cells, 3d, divides in a dexiotropic direction, whereas the other three cells of the quadrant divide in a læotropic direction. Since these cells were formed by a dexiotropic cleavage, the sub-division of 3d in a dexiotropic direction is a violation of the rule of alternation in successive cleavages, *i. e.*, it is a case of reversal. At the time of the division, however, this reversal is slight, the spindle being almost exactly radial; after the division the lower cell moves to the left, so that the position of the daughter cells is such as would result from a very decided dexiotropic cleavage. In the other quadrants the spindles are from the first decidedly læotropic in direction. The interest in this reversed cleavage is

increased, because it is one of the very first examples of bilateral cleavage in this egg. Owing to this reversal in quadrant D, the position of the third quartette cells in quadrants D and C is bilaterally symmetrical with reference to the plane separating the two mesentoblast cells, fig. 100. If this reversal had not occurred, the position of these cells would have been radially symmetrical, as in the other quadrants and as in all preceding cleavages. The causes of this reversal, therefore, have more than ordinary interest. In the formation of the third quartette the cell contents of 3d, as well as of all the other cells of this quartette, rotate in the telophase in a dexiotropic direction, and to about the same extent in all the cells, figs. 96, 97, 98, text figs. XV, XVI. The cause of this reversal cannot, therefore, be found in the absence or the reversal of the usual cell movements during the preceding telophase and rest. On the other hand, the cap of micromeres in quadrant D is so lifted from the macromeres by the formation of the mesentoblast cell that a space is left between the micromeres and the yolk, and into this space the lower product of the division of 3d pushes, fig. 100. This is not, therefore, so much a case of reversed cleavage as it is one of displacement of daughter cells. Such displacement may occur irrespective of the direction of division or of the movements of cell contents.

Further divisions have been followed in detail up to a late stage in the cleavage, but as they illustrate merely the principles which have been already described, no account is given of them here.

III. Analysis of Movements During Cell Division.

The movements within cells during the cycle of division may be classified under three heads: (1) Movements in Metakinesis, (2) Movements in Telokinesis, (3) Orientation of Centrosomes and Spindles. The first of these has been treated to a limited extent in Part I; however, only those features are there described which are of importance in understanding *nuclear* division; it will now be in order to consider these movements in their relation to the general cell movements.

1. *The Movements in Metakinesis* are of two kinds—movements in the spindle and aster, coincident movements in the cell body. (*a*) *Movements in Spindle and Aster.* As everybody knows the chromosomes, which may be widely scattered through the nuclear cavity, are first drawn into the equatorial plate of the spindle and then separated in the metakinesis, the daughter chromosomes moving toward the poles of the spindle as far as the spheres. Here the movements of the chromosomes cease (except in the single case of the maturation divisions where the chromosomes at the outer pole are pushed right on through the sphere, see pp. 19, 76), and here, in contact with the spheres, the chromosomes become vesicular and fuse to form the daughter nuclei.

The movement of the chromosomes into the equatorial plate is accompanied by a condensation or contraction of the linin network, which is at first uniformly distributed throughout the nucleus (*cf.* text figs. XVII, XVIII, with figs. 57, 65 and 84), and at the same time the greater part of the nuclear sap is squeezed out of this

mass of chromatin and linin into the peripheral portion of the nucleus, and when the nuclear membrane dissolves, into the cell body. The intra-nuclear spindle, although containing a considerable quantity of interfilar substance, is much denser than the surrounding nuclear sap; the radiations of this denser material which surround the equator of the spindle (see p. 18) are apparently due to the fact that in the shrinkage of the linin reticulum some of the fibres of the latter remain attached peripherally, and thus cause a stellate appearance of the spindle when seen in cross sections.

I have already indicated (p. 38) that the cause of the movements of the chromosomes in the metakinesis cannot be found exclusively in the contraction of the mantle fibres, though this may form an important factor; it is probable that this movement is associated with chemotropic attraction between the centrosomes and spheres (Strasburger, Wilson *et al.*). At the time when the chromosomes are being separated the interfilar substance of the spindle aggregates at the two poles, thus contributing to the growth of the spheres. It is probable that this movement is in the nature of diffusion streams, and that the cause of the movement lies primarily in the chemotropic influence of the centrosome. It is scarcely possible that this interfilar substance could be moved by the activity of the spindle fibres, and the fact that the chromosomes move to and partially surround the spheres indicates that their movement may be associated with the same factor which is active in the movement of the interfilar substance.

In the astral radiations the movements are also in the nature of diffusion streams, as was pointed out in the first part of this work (p. 49). In the growth of the aster the denser substance of the alveolar walls (hyaloplasm) is aggregated toward the centrosome, while the more fluid alveolar contents and all cytoplasmic inclusions, such as yolk, are moved farther and farther from the centrosome. The mechanical principles involved in this process have been worked out in detail by Rhumbler ('96). But in addition to this movement there is probably, in the earlier stages of mitosis, a diffusion of nuclear substance from the sphere along the astral radiations. This is indicated by the fact that these radiations stain like the central area of the aster, into which nuclear sap has escaped, and much more deeply than the hyaloplasm of the cell.

In the prophase of the third, fourth and fifth cleavages the upper pole of the spindle lies immediately under the old sphere substance, which at this stage forms a compact, lenticular mass immediately below the cell membrane, figs. 71, 72. In the metaphase this sphere substance is spread for a considerable distance under the cell membrane, its periphery being marked by a thickened ring of this material. As this substance spreads, the rays which go to its periphery remain large and deep-staining, thus forming a kind of "antipodal cone"[1] (Van Beneden), the apex of which lies at the centrosome and its base at the cell wall (text figs. XIX–XXIX). Within this cone the rays are faint and stain little, and the interfilar spaces are

[1] This name is used merely as a convenient descriptive term and without intending to homologize the structure observed by Van Beneden with the one here described. Rhumbler (1901) has called a similar structure in nematode eggs the "Polfontaine."

filled with a clear, non-staining substance. The regular spreading of this old sphere substance over the pole of the spindle is an actual demonstration of Bütschli's ('92, 1900) view that the poles of the spindle represent diffusion centers, from which substances spread over the surface of the cell. There is no conclusive evidence, however, that this diffusion consists of centrifugal movements within the astral rays themselves, since the spreading of the old sphere substance might be brought about by centrifugal movements of the substance between the rays or by peripheral movement of the entire spindle; there is actually such a movement of the spindle, as has been described already (p. 83).

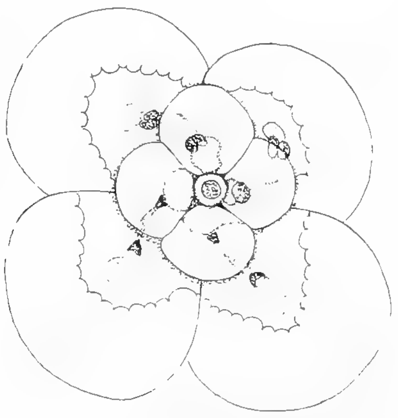

Fig. XXVIII.

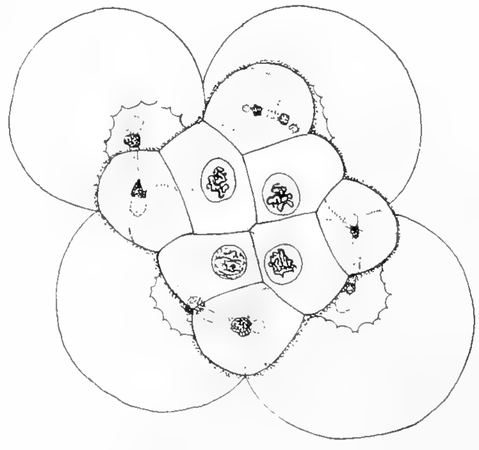

Fig. XXIX.

Figs. XXVIII, XXIX.—Late stages in the third and fourth cleavages of *Crepidula* showing the spreading of the old sphere substance in the form of a ring at the upper pole of the spindle.

In the late anaphase the sphere substance is again aggregated over the pole of the spindle; this is accompanied by a polar elongation of cytoplasm and the consequent separation of the pole of the spindle from the cell wall, together with the reduction of the angle of the "antipodal cone" mentioned above; at the same time the old sphere material is drawn in toward the centrosome, frequently in the form of a funnel, until its remnants lie close over the centrosome and new sphere, text figs. XXII, XXIII. It seems probable that the aggregation of the old sphere substance, the withdrawal of the astral rays and the coincident growth of the daughter spheres are all dependent upon centripetal movements along the rays during the anaphase.

There is good evidence in favor of the view that the astral rays are absorbed directly into the sphere in the later stages of mitosis. Thus the sphere increases in size and becomes rounded in outline as the astral rays diminish, and though the radiating arrangement of the alveoli may persist right through the resting stage (figs. 61, 69), the substance of the rays has largely disappeared when the spheres have reached their maximum size. Furthermore, after the separation of the daughter cells the spheres always become proportional in size to the volume of the cells in which they lie. Now, the first recognizable difference in the structure of unequal daughter cells is found in the size and extent of the astral rays; the

daughter nuclei, centrosomes and spheres are at first absolutely equal in the two cells, but the astral rays are always proportional in quantity to the volume of the daughter cells. Later, as the astral rays disappear, the spheres grow, becoming in the end proportional in size to the volume of these rays. These facts favor the conclusion that the substance of the astral rays flows into the spheres during the later stages of mitosis.

(*b*) *Movements in the Cell Body.*—While these movements are taking place in the spindle and asters other coincident movements are apparent in the cell body, which lead to the elongation of the cell in the spindle axis and to its ultimate constriction at right angles to this axis.

The elongation of the cell in the spindle axis takes place in every division, even though this axis, when fully elongated, may not be as long as the greatest diameter of the cell. This elongation of the cell may be symmetrical at the two poles, as is the case in all equal cleavages, or it may occur chiefly or entirely at one pole, as is true in very unequal divisions.

There are many reasons for believing that this elongation of the cell is due to a flow of cell substance into the polar areas from the equatorial region of the spindle. The most important of these evidences are found in unequal cleavages in which the elongation of the cell takes place chiefly or entirely at one pole. If one considers either of the maturation divisions or the formation of the first, second or third quartettes of *Crepidula,* one perceives that the cell as a whole does not elongate in the direction of the spindle axis until one pole of the spindle has come close to the cell membrane. After the sphere, and in the case of the maturation divisions, the centrosomes also, have been flattened against the cell wall, the latter protrudes from the general outline of the cell, and into this protrusion the sphere substance, the pole of the spindle and some of the cell substance passes. The elongation of the cell in this case is brought about by this protrusion at one pole of the spindle, and a study of the steps by which this is accomplished shows that there is (1) the movement within the cell which carries the spindle to a peripheral position and presses one pole against the wall, (2) a rapid growth of the cell wall over the pole of the spindle, especially in the area where the sphere is pressed against the wall, (3) a consequent diminution of surface tension at this point and a movement of the pole of the spindle and the cell substance into the protrusion thus formed. If the peripheral movement of the spindle is strong, it may be thrust into this protrusion as far as possible, as in the case of the maturation divisions; if it is less strong the growth of the cell wall and the outflow of cell substance may outrun the movement of the spindle, as is the case in the formation of the first three quartettes. Successive steps in the elongation of the cell preparatory to the separation of the quartettes are shown in text figs. XIX–XXV. It will be seen by these figures that during the prophase and metaphase the peripheral centrosome lies close to the cell membrane, and that the aster is pressed against the cell membrane in the form of a cone, the base and periphery of which are formed of the old sphere substance (sphere remnants of a previous cell cycle). In the metaphase of the third cleavage

this cone has an angle of about 130°. The cell membrane[1] begins to protrude over the base of this cone, the interior of which is filled with a clear non-staining substance; as the cell membrane protrudes, the space between it and the centrosome increases, for although the pole of the spindle moves into this protrusion, it moves more slowly and to a less extent than does the cell substance. During this period of protrusion the base of the cone withdraws from the cell membrane, and at the same time its angle decreases until finally it ceases to touch the membrane and becomes an irregular sphere, fig. 73.

That a similar elongation is taking place at the deeper pole of the spindle is shown by the facts: (1) that a protrusion of cytoplasm surrounding this pole is thrust down into the yolk, which, at the same time, is moved out of the axis of the spindle and up at the sides toward its equator, text figs. XIX–XXIII; (2) in abnormal eggs it frequently happens that a protrusion of the cell membrane takes place opposite the deeper pole of the spindle, as well as at its apical pole, only in this case the protrusion at the lower pole is filled with yolk and frequently ruptures the egg membrane altogether, text figs. XXX, XXXI. This protrusion at the lower pole, in connection with that at the upper one, shows that the surface tension is lessened at points on the cell membrane opposite the poles of the spindle, and further that this is associated with movements of the cell substance from the equatorial to the polar areas of the spindle.

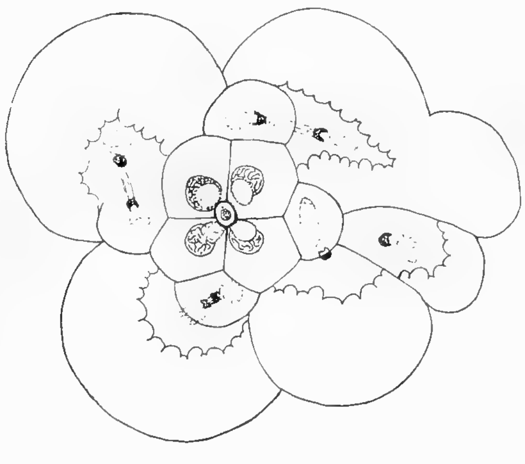

Fig. XXX.

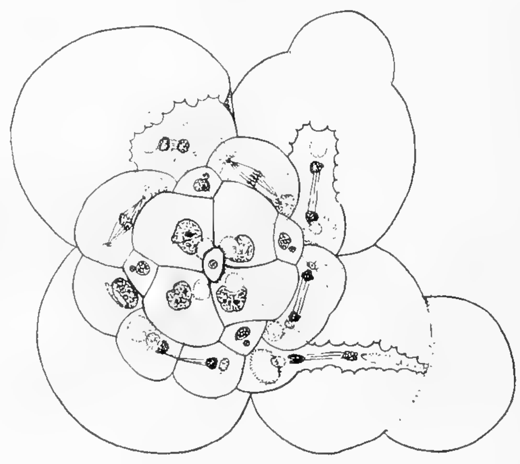

Fig. XXXI.

Figs. XXX, XXXI.—Abnormal stages in the formation of the second and third quartettes of *Crepidula*, showing a lobe of cell substance at both poles of certain spindles.

But while this polar flow of cell substance usually takes place in the spindle axis, it does not follow that the spindle or any part of it is the cause of the flow. On the other hand it sometimes happens in abnormal cleavages that the spindle does not move into its proper position, but remains in the area of one of the future daughter cells; in such cases the cell elongates in its usual direction, but not in the spindle axis, and the constriction and division of the cell body may be wholly typical

[1] In gasteropod eggs the cell membrane is merely a denser layer of protoplasm.

and wholly independent of the spindle, so that in the case mentioned one of the daughter cells would contain no part of the nucleus or spindle. Furthermore, the elongation of the cell usually takes place independently of the spindle in normal cleavages, for here the lobing of the cell is sometimes typically present at a time when the initial spindle may lie in any direction in the cell (*cf.* text figs. XXXII, XXXIII) ; only later is the spindle turned into the longest axis of the cell. We may conclude, therefore, that the elongation of the spindle is not the cause of the elongation of the cytoplasm, but that the latter is quite independent of the former.

The formation of these lobes of protoplasm in unequal cell division strongly resembles the formation of pseudopodia in amœba-like organisms. In the former, as in the latter, there is an outflow of cell substance due to the diminution of surface tension at certain points. In all unequal cleavages the reduction of surface tension takes place principally at one pole of the spindle, and in most of these cases this pole is directed toward the sphere substance of the preceding cell cycle. This old sphere substance lies at the free surface of the cell, immediately under the cell membrane. Here it is spread by the action of the aster, and its granular material probably contributes to the clear plasma of the "antipodal cone" and to the surface layer or cell membrane. A protrusion of cell substance occurs at this place, and into this protrusion the pole of the spindle moves.

The transformation of sphere substance, which is partly derived from the nucleus, into the surface layer or cell membrane affords an explanation of the diminution of surface tension at the poles of the spindle and the consequent elongation of the cell. It also affords a partial explanation of the greater diminution of surface tension at one pole than at the other and the consequent inequality of the resulting cleavage. It is not, however, a full and satisfactory explanation of unequal cleavage, as will be shown later.

In the formation of pseudopodia in amœba-like organisms Verworn ('92, '95) considers that "it is the chemical affinity of certain parts of the protoplasm for oxygen which leads to the reduction of the surface tension at definite places and so to pseudopod formation." How fully my observations on the eggs of gasteropods agree with these conclusions of Verworn will be apparent when it is recalled that sphere substance always moves to a free surface of the cell where it undergoes oxydation, and that in the end it probably takes part in the formation of the cell membrane or the surface layer of the cell.

The Equatorial Constriction.—The evidence which I have just adduced for movements of the cell substance from the equatorial to the polar regions bears also upon the equatorial constriction, since the withdrawal of substance from the equator and its aggregation at the poles must necessarily reduce the equatorial diameter.

Bütschli (1900) has, with characteristic insight, pointed out the fact that if the cell is of a fluid or semi-fluid consistency, the equatorial constriction must be the result of increased surface tension at the equator; and he concludes that the diffusion at the poles and the vortical movements within the plasma can have their origin either in increased tension at the equator or in diminished tension at the

poles. Rhumbler ('97, '99) has emphasized the important fact that in cytodieresis the total surface layer is increased, and that there must be a corresponding growth of the cell wall; he considers that this growth occurs principally in the equatorial plane. In egg cells, I am convinced that the growth of cell membrane takes place principally at the poles, and that the equatorial constriction is due, as Bütschli holds, to relatively greater tension at the equator, this being due to the growth of the membrane at the poles and the consequent decrease of tension at these points. In favor of this view are not only the observations which I have made as to the growth of membrane at the poles, but also the fact that in cells with pigmented surface layer the pigment moves away from the poles of the spindle, while the pigmented cell wall is carried down into the equatorial constriction and ultimately almost all the way through the division plane (see observations of Nusbaum, Van Bambeke and Rhumbler, mentioned later in section on movements in telokinesis). In such cases, therefore, the so-called "new cell wall" is largely the old cell wall, while the new wall is formed chiefly at the poles. However, the central portion of the division wall, *i. e.*, the portion lying near the mid-body, is a new formation.

While the factors just described explain the equatorial constriction, the complete separation of daughter cells and the constriction of the connective fibres of the spindle are probably due to other additional factors. I believe that the principal additional factor in this constriction may be found in the flow of substance from the poles to the equator, near the surface of the cell, and thence into the spindle axis. As evidence of such a flow, I adduce the movements of the yolk spherules in all the divisions of the macromeres, and particularly in the first and second cleavages (see pp. 79 and 81). In all these cases the poles of the spindle, surrounded by cytoplasm, move away from the equatorial plane, and at the same time yolk spherules at the periphery of the cell move toward the equator, and thence in toward the middle of the cell in the plane of the future cell wall. Such a movement is a true vortex, and it might be expected that the yolk spherules which are carried in along the plane of the approaching cleavage would then be carried out through the spindle axis to points on the surface opposite the poles of the spindle. Such, however, is not the case; the yolk spherules lie in the plane of the future cell wall, but never move out through the spindle axis. This cannot be held to demonstrate that there is no movement through the spindle axis toward the poles since the same forces which crowd the yolk spherules and large alveoles out from the centrosomes (see p. 91) would operate to prevent the flow of these large structures through the spindle axis toward the poles.

In all cells, whether they possess yolk or not, it is readily seen that during and after the metakinesis the cytoplasm in the equatorial region stains more faintly, and is composed of larger alveoles as division advances. In fact, the earliest indication in the cytoplasm of the plane where the equatorial constriction will occur is the clear, non-staining zone which runs through the cell in the plane of the future cell wall; this zone is composed of large alveoles with a relatively large amount of non-staining enchylemma and a small quantity of the stainable hyaloplasm. Soon after

the appearance of this clear zone the cell body begins to constrict in this plane, and there can be little doubt that the equatorial constriction is in part the result of the structure of this zone.

The equatorial constriction is, therefore, the result of at least three factors: (1) the decrease of surface tension at the poles and the consequent increase of surface tension at the equator; (2) the vortical flow of cell substance from the periphery of the cell into the spindle axis in the equatorial plane; (3) the structure of the cytoplasm in the equatorial plane, which is here composed of large alveoles with relatively large amount of enchylemma and small amount of hyaloplasm. It is probable that these different factors are all the expression of some common cause, which may possibly be found in the movements of the cytoplasm.

Comparisons.

It is interesting to note how recent work on the movements of cell contents was anticipated by some of the earliest writers on the subject of cell division—I refer especially to Auerbach ('74), Bütschli ('75, '76), O. Hertwig ('75, '77), Strasburger ('75), Fol ('75, '79), Whitman ('78, '87), Mark ('81), *et al.* All of these did their work, at least in part, on living cells, and it is instructive to contrast the plastic, kinetic conception of the cell which they all hold with the rigid, static one which has grown up in recent years, with the development of microscopical technique and the exclusive study of fixed material. Space will not here permit a review of the work of these founders of cytology on the subject of cytokinesis. References to several of these older works are found elsewhere in this paper and an excellent critical review of them may be found in Mark ('81).

To Bütschli, more than to any one else, we owe not only the conception of the structure of protoplasm which is here maintained, but also a mechanical theory of cell division which is built upon the movements of the protoplasm. As long ago as 1876 he considered the asters as diffusion centers (*cf.* views of Auerbach and Bütschli, p. 49), which could increase the surface tension at the equator, while reducing it at the poles; and although now and since 1892 he maintains that the asters exert an attractive influence on the cytoplasm he considers that this attraction (*Zugwirkung*) is still a factor in the constriction of the cell body.

Of all the observations which have heretofore been made on movements during metakinesis those of v. Erlanger ('97[2]) most resemble my own. In the living eggs of some small nematodes he observed strong movements in the cytoplasm in the maturation, fertilization and cleavage. The egg nucleus moves to the center of the egg, apparently by means of plasma streaming, and the approach of the germ nuclei is accomplished by such streaming. During the first and second cleavages the egg plasma shows decided streaming which sets the spindles into slow oscillating motion. The direction of this streaming is from the spindle poles toward the equator on the surface of the egg; at the equator it turns in at the furrow and returns to the poles through the interior of the egg. At the same time the astral rays are bent toward the equator, which still further confirms the existence of superficial

currents from the poles to the equator. These movements in the cytoplasm, though slow and weak, were actually observed by Erlanger in the living eggs. Bütschli (1900) suggests that the cause of this slowness of movement is the viscosity of the cytoplasm, "though powerful, turbulent vortical movements can have no part in normal cell division." The cause of these movements Bütschli finds either in increased surface tension at the equator, or in decreased tension at the poles.

A similar view as to the mechanics of cytodieresis was briefly expressed by Loeb ('95). He suggested that a mechanical explanation of the division of an egg or embryo was to be found in diffusion and vortex movements of the protoplasm, similar to those observed by Quincke in an emulsion of oil and soda solution. "I conceive," says he "that on the surface of the egg, possibly in the meridian or circle whose plane separates from one another the two radiating systems of the centrosomes, diffusion phenomena occur as soon as the nuclear division has physically ended. These lead to the formation of vortical movements, symmetrical in relation to this plane." If these movements are violent they lead to the complete separation of the daughter cells; if not, ordinary cleavage results. It will be observed that in two respects this view of Loeb's differs from Bütschli's and Erlanger's and from my own observations, *viz.*: (1) the diffusion phenomena are not limited to the equatorial circle, and (2) they occur before the nuclear division is ended. Later, Loeb ('95) observed in the segmenting eggs of *Ctenolabrus* droplets over the surface of the egg which collected in the plane of the next succeeding cleavage; this phenomenon he considered a confirmation of this theory.

The movements which occur during karyokinesis in *Crepidula* and other gasteropods entirely confirm the theories of Bütschli and Erlanger as to the mechanics of cell division. These theories also find confirmation in many other observations on a large number of animals. Among these may be mentioned the following:

Morgan ('93) observed that the reddish pigment granules found over the surface of the eggs of *Arbacia* move entirely away from the micromere pole of the egg before the micromeres are formed. In some eggs this movement begins in the two-cell stage, and is carried on until the micromeres are formed at the sixteen-cell stage. Nusbaum ('93) observed in the division of entoderm and mesoderm cells of young embryos of *Rana temporaria* that the brown-black pigment collected in a ring around the equator of the dividing cell, and as the division advanced the ring became narrower and deeper until it formed a true cell plate between the daughter cells. Van Bambeke ('96) has observed a similar phenomenon in the cleavage of the toad's egg. Gardiner ('95) observed in the eggs of *Polychœrus* and *Aphanostoma* a reddish yellow pigment, which, because of its form and peculiar movements, he supposed might be some form of alga. After the egg is laid it migrates from the center toward the periphery, and forms a girdle around the ovum in the plane of the first cleavage. A similar line of pigment marks out the division plane of every succeeding cleavage up to the ten-cell stage. He also observed that these pigment granules migrated from one pole of the egg to the other, though they never passed from one cell to the other. These movements greatly impressed Gardiner with the

wonderfully active and powerful forces within the egg. When the living egg is seen under an immersion lens, he says, "the surface fairly scintillates with the movements of the protoplasm and these pigment granules."

Fischel ('99) has observed a regular and orderly movement of granules, which stain with neutral red, in the living eggs of echinoderms. These granules, which are uniformly distributed throughout the cell during the rest, stream in toward the nucleus at the beginning of division and surround the division figure; after the division they are again distributed throughout the cell. In this case there is no accumulation of these granules in the plane of the cleavage; on the contrary, they move away from this plane. Rhumbler ('96, '99) has studied the movement of the pigment granules of amphibian eggs during division and finds that during the growth of the nucleus they collect around it; in the cytodieresis they are found in the plane of the division wall, and in all cases aggregations of the pigment are found only in thickenings of the hyaloplasm. Van der Stricht ('99) has observed in *Thysanozoon* that at the moment when the nuclear membrane disappears, fatty granules which were scattered through the cell accumulate around the achromatic figure, most of them being found at the equator of the spindle.

Rhumbler ('96, '97) has developed an extensive theory as to the mechanics of cell division. He holds that the spheres do not enlarge by the reception of nuclear substances (as Auerbach, Bütschli, Ziegler and I maintain), but that the nuclear sap is pressed out of the nucleus into the equatorial region of the cell, and that this nuclear sap goes to form the new cell membrane, the amount of membrane formed being proportional to the quantity of sap which escapes ('97, p. 697). I have elsewhere (p. 48) shown reason for believing that the nuclear sap first escapes at the poles of the nucleus and while a considerable portion of the sap may later escape in in the equatorial region, the assumption that the new cell membrane is formed by this sap and that the amount of membrane formed is proportional to the quantity of sap which escapes has little in its favor. Even though some of the sap may escape in the equatorial region it does not always lie where the division wall will form. In the first maturation division the new cell wall forms a considerable distance from the place where the nuclear sap escapes; and in the first and second cleavages the division wall appears all around the equatorial circle, though the sap escapes from the nucleus only in the cytoplasmic area near the animal pole. There is absolutely no reason for believing that in these divisions the nuclear sap collects all around the cell in the equatorial plane as it must do if the new division wall is formed from it. Moreover, the quantity of sap which escapes is not always proportional to the amount of membrane formed. In the case of the formation of the first polar body a larger amount of nuclear sap escapes than at any other mitosis in the whole course of development, yet the increase in the membrane is here perhaps less than in any other cell division, except the second maturation. Therefore, while recognizing the great value and suggestiveness of many of Rhumbler's conclusions, I cannot accept his views as to the formation of the division wall. In egg cells this wall is, as I have maintained elsewhere (p. 96), principally composed of old cell wall infolded at the equator, while the new wall is chiefly formed at the poles.

Rhumbler attributes the phenomena of cytodieresis to at least five factors: — (1) The pull of the astral rays, (2) the pull of the central spindle, (3) the rounding of the cell, (4) the growth of the membrane, (5) the decrease of the nuclear lumen. According to my view the most important factors of all are omitted from this category, viz.: (1) the decrease of surface tension at the poles and the consequent elongation of the cell in the spindle axis, and (2) the vortical flow of cell substance.

2. *Movements during Telokinesis.*—The cell movements during telokinesis are of a rotary character, the spindle axis and cell contents in each daughter cell moving through an angle varying from 30° to 180°. In my former paper ('99) on these movements I did not sufficiently distinguish between the vortical movements of karyokinesis and the rotary ones of telokinesis. There is abundant evidence, however, that the movements of telokinesis are in the main of a rotary and not of a vortical character. The halves of the spindle shift their positions so that they come to lie close to each other on opposite sides of the new cell wall; in general, there is no flow of one portion of the cell contents through another, but all parts rotate in a given plane around some point which serves as a center. In the first and second cleavages the center of rotation is approximately the center of each daughter cell. In the later cleavages the center of rotation varies in different cell generations, but is usually above the center of the cell, *i. e.*, nearer the animal pole, in the case of the micromeres and below the center or nearer the vegetal pole in the case of the macromeres.

(1.) In this rotation the entire cell contents take part; there is not merely a bending of the spindle axis but also a movement of the cytoplasm and yolk. During this rotation the half of the spindle axis in each daughter cell is preserved as a straight line, the bend in this axis occurring only at the mid-body. Throughout the telokinesis the spindle fibres may be recognized connecting the mid-body and nucleus and in some cases passing around the nucleus to the centrosome and sphere, figs. 61, 73. The bending of the spindle axis on itself in the two daughter cells, rather than its rotation with the cytoplasm and yolk, is thus explained by the persistence of the spindle fibres, which attach the structures of the spindle axis to the mid-body. Throughout this rotation the nucleus preserves its polarity, its grooved side (central pole) being turned toward the centrosome, though this general rule may be departed from to a limited extent in cases where the movements of the nucleus or centrosome are interfered with. In the cytoplasm, radiating rows of alveoles are present during the whole of this rotation; in the first and second cleavages they become curved, as shown in figs. 61 and 69. They are entirely lacking on the side of the spindle axis next the new cell wall, where the cytoplasm is clear, non-stainable and shows no traces of alveolar structure.

(2.) The movements in the two daughter cells are always in opposite directions and are always toward the animal pole; consequently, if the rotation is dexiotropic in one cell it is læotropic in the other. In all spiral cleavages the movements in the upper cell are in the direction of the cleavage by which that cell was formed; thus the first quartette is formed by a dexiotropic cleavage, and the rota-

tion in these cells is dexiotropic, the second quartette is formed by læotropic cleavage and the rotation in these cells is læotropic, etc.

(3). The extent of the rotation differs somewhat in different cell divisions and for different cell constituents, but in all cases there is an evident tendency to carry the poles of the spindle axis to that portion of each daughter cell which lies nearest the animal pole, though this movement is limited by the fact that the spheres do not move away from a free surface and under other cells. Normally the nuclei lie close to the centrosomes and although they may move into that portion of the cell which is overlapped by other cells, they do not separate from the centrosomes; hence it may be concluded that their movements are indirectly limited by this tendency of the spheres to keep in contact with a free surface of the cell.

(4). As a result of the fact that the spheres do not move under overlapping cells, but lie close to a free surface, the centrosomes, nuclei and cytoplasmic areas of the macromeres move down over the periphery of these cells as the cap of ectoblast cells extends until finally they are carried clear around to the vegetal pole. In this way the polarity of these cells is apparently reversed, the nuclei, centrosomes and cytoplasmic areas being carried from the animal to the vegetal pole, in front of the margin of overgrowing ectoblast cells. Another result of the fact that the centrosomes and spheres lie in contact with a free surface of the cell is that the cells are formed in a one layered epithelium and not in a many layered one or in a solid mass. Cells are not budded off from the macromeres under the cap of ectoderm cells but at its edge, and in the subdivision of the ectoderm cells the same principle is operative; thus although the ectoderm cells may overlap one another to a certain extent they are never completely covered by other cells but always preserve a free surface. Heidenhain ('94) has shown that in one layered intestinal epithelium the centrosomes during the rest lie between the nucleus and the free surface of the cell; in division the centrosomes lie 90° from this position, the spindle being paratangential with the free surface of the cell; he has pointed out the fact that if the angle of rotation of the centrosome were different an entirely different form of cell complex might result. In *Crepidula* it is not the angle of rotation which determines that the ectoderm shall form a one-layered epithelium, since this angle varies with every cleavage, but the fact that in the rest the centrosomes and spheres lie next a free surface of the cell.

In the formation of the mesentoblast (4d), however, there is an important exception to this general rule. In the late anaphase of this cleavage the centrosome and sphere are still in contact with a free surface of the cell 4d, (text fig. XVI) but in the telophase the nuclei, centrosomes, spheres and cytoplasmic areas are carried under the overlying ectoderm cells, only that portion of the cell which contains yolk remaining at the surface. It is difficult to observe the centrosomes and spheres in the cells derived from 4d, but during the first two or three cleavages they lie on the apical, *i. e.*, animal pole, side of the nuclei during the resting period, fig. 100. In all these derivatives of 4d the spheres stain less densely and are larger and less definite in outline than in those cells in which they are in contact with a free surface. I

have been unable to determine why the centrosomes and spheres in this single case move under other cells and thus give rise to a middle layer.

(5). Generally these telokinetic movements continue throughout the whole of the period which is commonly called the "rest." They grow less and less evident, however, as the prophase of the next division approaches and, for a brief period before the next cleavage begins, cease altogether. This brief period we may call the "pause" (Fol '96). During the pause the nuclei frequently lie in that portion of the cytoplasm which will form the larger of the two daughter cells at the next division. Thus in the pause preceding the first subdivision of the first quartette the nuclei lie as close as possible to the animal pole, figs. 76, 91, 92, 93, and these portions of the cells become the large cephaloblasts at the following cleavage; in the pause preceding the second division of the first quartette, the nuclei lie some distance from the animal pole in those portions of the cells which will become the large basal cells at the next division, fig. 96, text figs. XIV, XV. This signifies more than that the nucleus lies in the center of its working sphere, since the nucleus does not lie in the center of the cytoplasm, but always in a position which has reference to the future division; the equality or inequality of the division is already predetermined before any trace of that division has appeared.

(6). Finally, the movements in telokinesis are in some way caused by the polarity of the protoplasm of each cell; in fact every blastomere behaves much as does the entire egg before cleavage begins, its substance rotating until the cytoplasm, nucleus, centrosome and sphere are carried to that portion of the cell nearest the animal pole. During the cleavage the spindles lie in many directions and cells are formed in many positions, but after every division the original polarity of each cell is, as far as possible, restored. Further, this rotation may be associated with the movement of the poles of the spindle, through chemotropic influence, to a free surface of the cell. The fact that the spheres become pressed against the cell membrane and that in this position they undergo changes in form and staining reactions, staining more deeply and becoming more coarsely granular, suggests that they here undergo some chemical change, probably an oxydation.[1] This factor, however, will not account for the fact that the spheres move in a predetermined course as near as possible to the animal pole and that the whole cell contents move with them; this movement is evidently reducible to that class of movements which brings about the polarity of the egg, but the causes of these movements I am unable at present to analyze further.

Comparisons.

(*a*) *Protozoa and Protophyta.*—Lauterborn ('96) has observed that the nuclei and centrosomes rotate through an angle of 180° at the close of division in diatoms.

[1] Attempts to determine experimentally whether the spheres move to a free surface under the influence of oxygen have so far been inconclusive, since all movements, as well as other developmental processes cease in the complete absence of oxygen (*e. g.*, in an atmosphere of hydrogen). However in sea water which has been boiled in order to drive off contained gases and then cooled in stoppered tubes, eggs develop irregularly, the micromeres no longer being arranged in a one-layered epithelium over the yolk, but forming irregular heaps and masses, such as would result from the failure of the spheres to move to a free surface.

R. Hertwig ('99) has seen a similar phenomenon in *Actinosphærium*. He says, p. 692, "Ehe die Theilung zu ende geführt ist, wird die Spindelkörper bei der typischen Karyokinese der Actinosphærium über eine Seite gebogen, so das die Tochterkerne später dicht bei einander liegen (taf. III, figs. 10, 11) oder er wird bei dem Richtungstheilungen fast rechtwinkelig eingeknickt (taf. V, figs. 15, 16)."

(*b*) *Tissue Cells and Testis Cells.*—M. Heidenhain ('94) in his great work on the centrosome first described in detail the bending of the spindle axis and the movements of the centrosomes and nuclei at the close of division. These movements he designated "Telokinesis" and he properly recognized that they constitute the final stage of cell division to which he gave the name "Telophase."[1] These movements were observed in leucocytes and one-layered epithelium, and Heidenhain supposed that they might be present in the division of many other cells. According to Heidenhain the movements of the microcenter take place in a curve parallel to the surface of the cell, while the nucleus probably moves in the reverse direction. In one-layered epithelium the axis which passes through the microcenter and nucleus, *i. e.*, the cell axis, moves through an angle of 90° after each division; in embryonic development it moves through varying angles. The result of these movements is to bring the microcenter to the center of the cell and the nucleus to a peripheral position. Heidenhain was unable to determine whether in these movements the nucleus rotates so as to preserve its inner polarity. The cause of these movements he finds in the contraction and expansion (*Spannung*) of the organic radii, *i. e.*, through a lengthening of the polar group of radii and a shortening of the radii which stretch over the nucleus to the opposite side of the cell.

Erlanger ('96) found in the division of the branchial epithelial cells of the salamander that the daughter cells regularly turn through an angle of 90° or more toward the spindle axis of the mother cell.

Similar movements have been observed in testis cells by Meves ('94, '96), Moore ('95), and Prenant ('95). The latter has seen extensive movements of the microcenter in the telophase of the testis cells of *Scolopendra*. The microcenters of the two daughter cells are inversely symmetrical with reference to the axis which joins the nuclei, the one being situated to the right the other to the left of that axis. In some cases, however, the microcenters lie on the same side of the axis, *i. e.*, the symmetry is not inverse. Remnants of the spindle remain as a "perinuclear band," which, he thinks, may be the agent of the movements of the microcenters. He does not agree with Heidenhain that the microcenter lies in the center of the cell during the rest, and this is certainly not true of the mollusks which I have studied.

In the spermatocytes of elasmobranchs Moore finds that the centrosome, surrounded by archoplasm, wanders toward the equator, and when it has reached a point between the pole and the equator it moves to the cell periphery; the centrosome here lies between the chief mass of archoplasm and the cell wall.

[1] The custom of using this term to designate the final stages of the anaphase (*cf.* Wilson '96 and 1900, Coe '99, Griffin '99, *et al*) is to be deprecated, since Heidenhain's definition of this term is perfectly explicit and the stage to which it applies is clearly marked off from the anaphase.

Meves ('96), in the spermatogonia and spermatocytes of the salamander, finds the center close under the cell wall in the anaphase; in the case of the smaller spermatogonia and spermatocytes the centers move from this position through an angle of 45° to 135°; in the larger spermatogonia no lateral movement takes place, but only a movement toward the equator in the spindle axis, which is probably caused by the contraction of the earlier spindle fibres. Meves believes that the lateral movements of the centers in the smaller cells are caused by the development of large and numerous astral rays on the side from which the centers move, which rays serve to push the centers into their new positions. These movements do not take place in a definite direction nor are they in the same plane in the two daughter cells. In the eggs which I have studied this movement cannot be caused, as Meves assumes, by the pushing of polar rays on the side from which the centers move, for in these eggs the whole cell contents rotate, as has been described.

Montgomery ('98) has observed in the testis cells of *Pentatoma* that the new centrosome appears at a point in the cell about 180° from that occupied by the old centrosome. He has also observed that the idiozome material moves from the poles to the equator of the dividing cell.

(*c*) *Ova and Blastomeres.*—Mark ('81) first observed and figured a bent spindle axis in the egg of *Limax* (see his figs. 91 and 93, in which the middle of the spindle is shown displaced toward the center of the egg). MacFarland ('97) has shown the same thing in one of his figures of *Pleurophylidia* (fig. 20), though he figures the centrosomes as lying below the level of the nuclei, a thing which I have never observed in any mollusk.

Kostanecki ('97) says that in the cleavage of *Physa* the daughter cells take opposite positions in the telophase while they turn against the spindle axis through an angle of as much as 90.° The *Zwischenkörper* does not, therefore, lie in the middle of the equatorial constriction, but is shoved to one side.

Quite recently Rhumbler (1901) has described a periodic movement of the nucleus to the cell surface within the living blastomeres of certain nematodes. At the close of each cell division the nuclei migrate to certain places on the cell surface, which places lie in the plane of cleavage of the following cell division. Between the nucleus and cell surface Rhumbler has observed a clear area which he calls the "Polfontaine," and which probably corresponds to the sphere of *Crepidula*. The movements observed by Rhumbler entirely correspond to the movements in telokinesis which I had previously described ('99) though he has evidently overlooked my paper on this subject.

Zur Strassen (1901) also has recently described the position of the centrosome in the resting cells of *Ascaris megalocephala*. In brief, he finds that during the resting period the centrosomes lie close to the cell surface, and he describes in detail the symmetrical movement of the centrosomes and spheres toward the division plane between two daughter cells. This movement in every respect resembles the movements in telokinesis which I have described, and applies to the nuclei as well as to spheres. Zur Strassen further finds that the form of each cell changes with the

movements of the sphere, the cell wall being especially prominent over the sphere. He also discusses in a very suggestive manner the relation of these movements to the morphological and physiological polarity of the cell.

This is doubtless an incomplete list of the cases which have heretofore been observed in which there is a decided bending of the spindle axis at the close of division, but the cases are sufficiently numerous to indicate that this is probably a general phenomenon.

3. *Orientation of Centrosomes and Spindles.*—The centrosome, which during the anaphase is usually spherical, becomes ellipsoidal or spindle-shaped during the telophase and rest. The axis of elongation of the centrosome becomes the initial spindle axis. It is nearly constant in direction for any given cell generation, but differs somewhat in different generations. No general rule can be formulated with regard to the relation of this initial spindle axis to the old spindle axis, or rather the half of it which lies in each daughter cell, but the new axis is most frequently at right angles to the old, figs. 82, 83, 86, 91.

As the initial spindle elongates and the peripheral layer of the old centrosome disappears, the new spindle moves out of the old sphere, which at once becomes irregular in outline; at the same time the new spindle moves over the surface of the nucleus until it comes to lie in the groove separating the germ halves and until the poles of the spindle lie at opposite sides of the nucleus. In some cases the initial spindle lies almost in the groove between the germ halves of the nucleus when first formed (*e. g.*, prophase of the second cleavage, figs. 82, 83, text figs. VII, VIII); in other cases it must move some distance before taking up this position (*e. g.*, earliest stages in the third and later cleavages, figs. 86, 88, 91).

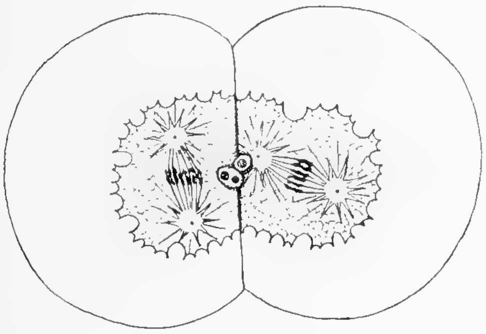

Fig. XXXII.

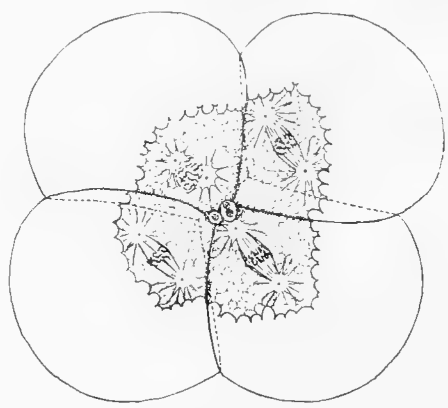

Fig. XXXIII.

Figs. XXXII, XXXIII.—Metaphase of the second and third cleavages of *Crepidula*, showing an unusual position of certain spindles; these ultimately rotate into normal positions.

The position of the initial spindle in the nuclear groove does not always correspond to its definitive position. In many cases the latter is reached only after more or less extensive movements of the entire mitotic figure (*cf.* fig. 88 and text figs. XXXII and XXXIII). These movements are of two kinds, a rotation of the spindle into its definitive axis and a transportation of the entire figure to its final position in the cell, figs. 93, 94.

The orientation of the centrosome and spindle has reference therefore to two different things, (1) the relation of these structures to the nucleus, (2) their relation to the cell body.

(1). *Orientation of Centrosome and Central Spindle relative to the Nucleus.*—It is evident that some kind of connection exists at all stages of the cell cycle between the centrosome and the nucleus. This is of course most evident during division when the two are connected by the spindle fibres, but even during the rest there must be some connection since the two lie in close contact and except in abnormal cases do not separate. Whether this connection during the rest is in the form of fibres (possibly a persistence of those which previously connected centrosome and chromosomes) or is the expression of some other mechanical action or of a chemotropic attraction does not appear from my studies. The movement of the initial spindle out of the sphere and into the groove between the germ halves of the nucleus must be attributed to some such connection between the centrosome and nucleus. Of course the mere separation of the centrosomes until they lie as far apart as the diameter of the nucleus may be attributed to the growth of the central spindle.

(2). *Orientation of the Mitotic Figure relative to the Cell Body.*—In the early prophase the entire mitotic figure moves in a direction opposite to that of the previous telophase; or, in a word, the prokinesis is the reverse of the preceding telokinesis. For example, in the telophase of the first cleavage the cell contents move in a dexiotropic direction until nuclei, centrosomes and spheres are carried close to the division wall and near to the free surface of the cells, fig. 82; in the following prophase they move away from the division wall, in a læotropic direction and deeper into the cell (*cf.* figs. 82 and 84, also figs. 63 and 65). In the telophase of the second cleavage the daughter nuclei and centrosomes move close to each other on opposite sides of the division wall, fig. 86, and then into the apical angles of the cells, fig. 87; in the following prophase they move farther from the apical pole and a little deeper into the cell, (*cf.* figs. 87 and 88). In the telophase of the third cleavage the nuclei of the macromeres move in a læotropic direction until they come into contact with the wall at the left of these cells, and toward the apical pole until they are almost entirely covered by the overlying micromeres, fig. 91; in the prophase of the next division of these cells the mitotic figures move away from the animal pole and a little to the right, (*cf.* figs. 91 and 92). In the telophase of the third cleavage the nuclei of the micromeres move to the right and as near to the animal pole as possible, fig. 92; in the prophase of the next division of these cells the mitotic figures move away from the animal pole and a little to the left, (*cf.* figs. 93 and 94). The same principle is shown in the first division of the second quartette (*cf.* figs. 95 and 96). In fact it may be laid down as a general rule that the movement in the prophase (prokinesis) is in the reverse direction of that in the telophase (telokinesis), though usually not so extensive.

Other movements of cell contents, which bring about peculiarities in the direction of division and hence peculiar types of cleavage (radial, spiral, bilateral), or

marked eccentricity of the mitotic figure and subsequent inequality of cleavage are intimately associated with processes of differential cell division and the discussion of this subject is postponed to the next section. It need only be said here that there are many evidences that the movement of the entire mitotic figure into its definitive position is a function of the cytoplasm, rather than of the nucleus, centrosome or spindle. This movement does not occur until after the nuclear membrane is dissolved at the poles of the spindle and it is probable therefore that the escape of substance from the nucleus acts as a stimulus to the cytoplasm which then moves and behaves in a predetermined manner.

IV. Some Factors of Differentiation.

In conclusion a brief summary may be given of the bearing of cytokinesis on problems of differentiation. In the main, differentiation in the early development of an animal consists in the formation of various unlike substances and in their definite localization in different regions of the egg or in different blastomeres. In this localization one of the most important principles is polarity.

1. *Polarity:* (*a*) *Unsegmented Egg.*—The polarity of the egg, by which is meant the localization of unlike substances and structures with respect to a single axis, the chief axis of the egg, is indicated before maturation by a slight eccentricity of the germinal vesicle; the latter is, however, entirely surrounded by yolk and the cytoplasm is uniformly distributed throughout the egg. About the time of the entrance of the spermatozoon the wall of the germinal vesicle dissolves and at once movements within the egg substance begin which ultimately lead to the segregation of yolk at one pole and of cytoplasm at the other. There is good evidence that this segregation takes place along preexisting lines of structure, the cytoplasm, mitotic figure and escaped achromatin moving to that pole toward which the germinal vesicle was eccentric, and in all cases this probably corresponds to the free pole of the epithelial cell from which the egg was derived.

In the gasteropods which I have studied this movement is in no way correlated with nor influenced by gravity, the place of entrance of the spermatozoon, nor, so far as I can see, by any other extrinsic factor. The fact that in some animals the yolk has a greater specific weight than protoplasm has led O. Hertwig ('93, p. 215) to assert as a general law that "Polar differentiation consists in this, that the lighter protoplasm collects at one pole and the heavier yolk substance at the other." Rhumbler ('99, p. 568), also says "Incontestibly the yolk granules (in telolecithal eggs) are collected in the lower part of the egg through their greater specific weights." Where the yolk is heavier than the protoplasm this may of course be true, but it is by no means generally applicable. In many well known cases among annelids, mollusks and arthropods gravity has no determining influence on the polarity of the egg which is established in a predetermined axis irrespective of the position of this axis with reference to the direction of gravity.

In the gasteropods both polar bodies are extruded at the same point on the surface of the egg, and the animal pole thus established bears an invariable relation to

all future development. Through this pole the first two cleavage furrows always pass; around it three quartettes of ectomeres are formed, each of which has a definite developmental history and gives rise to definite parts of the larva or adult; certain of these blastomeres are visibly different from each other in size, position, shape and quality, and although these differences arise gradually in the course of development, the polarity of the unsegmented egg exercises a determining influence upon all of them. This polar differentiation of the egg is therefore of the greatest prospective significance.

The eccentricity of the germinal vesicle, which is the earliest evidence of this polarity in the free egg, is itself, most probably, the result of polarity already existent in the cell from which the egg is formed. This polarity must be regarded as the factor which directs the general cell movements which bring about the segregation of yolk and cytoplasm; while the immediate cause of these movements is very probably the escape of achromatic substances from the nucleus.

In the fertilization of the egg the same sorting of the egg contents continues as in the maturation, with the result that at the beginning of the first cleavage almost all of the yolk is collected at the vegetal pole while the greater part of the cytoplasm lies close around the animal pole.

(*b*) *Blastomeres.* Every blastomere manifests the same type of polarity as the unsegmented egg itself. At every cleavage this polarity of the blastomeres is lost or modified, only to be reestablished again in each telophase. In every division of blastomeres containing yolk the mitotic figure surrounded by cytoplasm moves down into the yolk area while the yolk moves up at the periphery toward the animal pole. In the telophase and resting period, however, the centrosomes, nuclei and cytoplasm again take a superficial position near the animal pole, while the yolk again moves toward the vegetal pole. This polar movement concerns not only cytoplasm and yolk but also different kinds of protoplasm. Thus the sphere substance always takes a definite polar position in each blastomere and the localization of certain characteristic kinds of cytoplasm (hyaline or granular) is also referable to polarity.

In each blastomere the cell axis (Heidenhain), by which is meant the line passing through the center of the nucleus and centrosome, shifts during the telophase until the centrosome and sphere are carried to a free surface of the cell and as close as possible to the animal pole. The result is that in all the early cleavages the cell axis tends to become parallel with the original egg axis, though this is prevented in many instances by other cells which lie nearer the animal pole.

(*c*) *Nucleus, Centrosome and Sphere.*—During the rotation of the cell contents in the telophase the spindle axis rotates as a whole so that the nucleus at all stages in this rotation presents approximately the same side (its central pole) toward the centrosome and sphere, and its opposite side (distal pole) toward the mid-body. Throughout this rotation the centrosome and sphere also present the same side toward the nucleus. The polarity therefore of the nucleus, centrosome and sphere, as well as that of the cell body, is reestablished after every division.

The immediate cause of these telokinetic movement, as also of those in the unsegmented egg, may be found at least in part in the movement of the spheres to a free surface of the cell, but the orientation of these movements cannot at present be further explained than to refer them to the structure of the protoplasm.[1]

2. *Differential Cell Division.*—As has been emphasized already (p. 6), cell division is typical and non-differential when it occurrs at regular intervals or at the same time in cells of the same generation (rhythmical), when successive divisions are at right angles (alternating), when the daughter cells are of similar size (equal) and are composed of similar materials (homogeneous). Divisions are differential when they depart from these typical conditions in one or more respects, thus becoming non-rhythmical, non-alternating, unequal or heterogeneous.

(*a*) *Rhythm of Division.*—A definite order of cleavage is highly characteristic of gasteropods. In *Crepidula* one of the first two blastomeres usually divides slightly earlier than the other, and in the formation of the first, second, third and fourth quartettes one cell of each quadrant forms earlier than the other three. These differences in the time of formation of the different cells of a quartette are least in the first quartette and greatest in the fourth, where the cell 4d is formed at the 25-cell stage while the other cells of this quartette are not formed until the 52-cell stage. In the subdivision of the different quartettes this same lack of rhythm is observed, the cells which formed first being usually the earliest to divide. To this rule, however, there are several notable exceptions; for example, the trochoblasts which are formed at the first division of the first quartette do not again divide until more than one hundred cells are present. In this case the lack of rhythm in the divisions leads to important differentiations, since the large trochoblasts give rise to certain of the large cells of the velum and head vesicle.

The old view (Balfour '80) that the rate of division depends upon the presence or absence of yolk, cells with yolk always lagging behind those without it, is untennable since this lack of rhythm frequently concerns purely protoplasmic cells. For example, none of the ectomeres of *Crepidula* contain yolk, yet they divide at very different rates, while on the other hand many yolk-laden cells divide more frequently than those without yolk (see Wilson, 1900, p. 366).

The rhythms of division of centrosome, nucleus and cell body go on more or less independently of one another. Boveri ('97) has shown that in echinoderm eggs the centrosomes preserve their rhythm of division even when separated from their nuclei, and I have observed the same thing in enucleated blastomeres of *Crepidula*. Furthermore, the rhythm of cell and nuclear division are more or less independent of each other; in certain abnormal eggs of *Crepidula* I have observed that normal and characteristic cell division may occur in enucleated blastomeres, and on the other hand nuclear division may go on in regular manner and at regular intervals in the absence of cell division. There is therefore no absolutely necessary connection between the division of nucleus, centrosome and cell body.

Driesch ('98) has shown that in cross-fertilized eggs of echinids the rhythm of

[1] See similar conclusions reached by Lillie (1901) in the case of *Unio*.

cleavage is that of the maternal and not of the paternal species; in this case the rhythm depends upon the egg cell and not upon the sperm and therefore, in all probability, upon the cytoplasm and not upon the nucleus or centrosome.

While the divisions of nucleus, centrosome and cell body may occasionally go on more or less independently, it is certain that they are normally intimately connected, and I believe that the normal rhythm of division is largely determined by the interrelation of these structures. In *Crepidula* it is always possible to determine whether or not a cell will soon divide by the relative size of the nucleus as compared with the cell body. Both nucleus and cytoplasm increase in volume after each division, but the nucleus increases much more rapidly than the cytoplasm.[1] When the nucleus has reached a certain maximum size relative to that of the cell body it enters upon the prophase of the next division. The centrosome sometimes divides and gives rise to the initial spindle before the nuclear prophase and in such cases it seems to wait for the nucleus before going through the further stages of its separation. The cytoplasm also sometimes elongates in the direction of the coming division, but seems to wait for the nuclear prophases before undergoing constriction.

Strasburger ('93) determined the relative size of the nucleus to the cell body in some forty species of plants. He found that while this ratio differed in different species and in different organs of the same species, yet in a given organ of a given species it was quite constant. The average ratio of nuclear to cell diameter in embryonic cells he found to be about as 2:3. When the diameter of the cell, as compared with that of the nucleus, exceeds this ratio, cell division occurs and the ratio is thus restored.

In *Crepidula* it is difficult to establish such a ratio owing to the differences in in the shapes and dimensions of cells in the early cleavage; I have, however, measured a number of cells and nuclei in the prophase of the first maturation and of the first, second and third cleavages, and the ratio of the nuclear to the cell diameter in these yolk laden cells is about 2:7. Such measurements show that at the moment of division there is a fairly definite ratio between the diameter of the nucleus and that of the cell, but whether the growth of the nucleus beyond this ratio is a stimulus to division or is merely an accompaniment of it, is not indicated.

(*b*) *Direction of Division.*—Upon the direction of division depends the relative positions of the daughter cells and consequently the type of cleavage, viz.: radial, spiral, bilateral or teloblastic. In determinate cleavage this is an important factor of differentiation since it leads to the localization of cells and different cell substances.

The direction of cell division has been attributed by various authors to a variety of factors; thus it is said to be due to the fact that the mitotic figure lies in the direction of least resistance (Pflüger), or in the longest axis of the protoplasmic mass (Hertwig); the shape and position of cells and consequently to a certain extent the direction of division, are said to be due to the rectangular intersection of cleavage

[1] Since the egg as a whole does not increase in size until the gastrula stage the increase in the quantity of cytoplasm must be at the expense of the yolk.

planes (Sachs), or to the principle of smallest surfaces (Plateau, Berthold). Almost all investigators agree that the direction of division is due to the position of the mitotic figure and the orientation of the figure is usually supposed to be actively produced by the figure itself, or by some part of it. According to Roux ('95) there is immanent in the nucleus, a direction of division which may be independent of the chief dimensions of the protoplasmic body. Rauber ('83) holds that the position of thespindle is the result of the mutual attractions of neighboring asters. Heidenhain ('94) refers the direction of division to a definite angle of rotation of the centrosomes.

In the segmenting eggs of the gasteropods which I have studied the direction of division is not primarily due to any of the factors named, though several of these principles are well illustrated in these cells. The spindle usually, though not invariably, lies in the longest axis of the protoplasmic mass and it probably always lies in the direction of least resistance, though this in itself is no explanation of the direction of division. As has already been pointed out (p. 105), the angle of divergence of the centrosomes and the initial position of the mitotic figure may not correspond with its final position, while at the same time the lobing of the cytoplasm may indicate the final position of the spindle and the direction of the coming division; in fact the form of the cell and the movements of the cell contents may proclaim where the next division will occur long before the spindle is formed.

The alternation in the direction of successive cleavages is not due to the mere divergence of the centrosomes in planes successively at right angles to one another, but rather to regular alternations in the rotations of the cell contents; the lack of alternation is associated (at least in one generation of cells, see p. 88) with the lack of rotation of the cell contents during the preceding telophase.

When for any reason the mitotic figure is prevented from assuming its normal position, the cytoplasm may divide in the normal place and manner, thus giving rise to a cell which is normal in appearance except that it contains no part of the nucleus or spindle.[1] From these facts I conclude that the position of the spindle is the result of movements and stresses in the cytoplasm. In normal cell division the spindle takes a position of equilibrium between the two portions of the dividing cell, so that the equatorial constriction cuts through the middle of the spindle; if, however, the spindle is prevented from assuming this position of equilibrium it may be cut through nearer one end than the other or may be left entirely to one side of the new cell wall. Therefore the position of the spindle and the direction of division are functions of the cytoplasm, rather than of the nucleus, centrosome or spindle.

(*c*) *Size of Daughter Cells.*—The inequality of cell division leads to some of the most characteristic and important features of differential cleavage, while the varying sizes of blastomeres have a definite prospective significance in development, as Lillie ('95, '99) and Conklin ('97, '98) have pointed out.

[1] I have seen several such cases, but a more detailed account of them must be postponed to another paper.

The inequality of cell division is most commonly referred to the eccentricity of the mitotic figure, however this may be caused, (see Wilson 1900); but it is sometimes associated with a lack of symmetry in the spindle itself. Thus R. Hertwig ('99) finds in *Actinosphærium* that one pole of the spindle (*Richtungskörperpol*) differs decidedly from the opposite pole, and the new cell wall cuts the connective fibres nearer this pole than the other. In the second maturation also the two centrosomes are unequally developed. Likewise Vejdovsky and Mrazek ('98) find in the late anaphase of the first cleavage of *Rhynchelmis* that the centrosome (*Tochterperiplast*) and sphere (*Mutterperiplast*) at one pole are much larger than those at the other, corresponding to the fact that the first cleavage is very unequal in this animal. A similar disparity in the size of the two centrosomes and asters has been observed by Wilson ('94) in *Nereis*, Kostanecki and Wierzejski ('96) in the first maturation of *Physa*, Lillie ('99) in the first cleavage of *Unio;* but in all these cases except possibly that of *Actinosphærium* the disparity does not appear until after the spindle has taken an eccentric position in the cell.

In all the divisions of eggs and blastomeres, among the gasteropods which I have studied, not only the centrosome but every portion of the mitotic figure divides with exact equality, however unequal the approaching cell division may be. The chromosomes not only divide equally, but each half is a mirrored image of the other in shape as well as size. If one may judge by the form of daughter chromosomes, the division is qualitatively as well as quantitatively equal. The centrosomes and asters at the two poles of the spindle are also exactly equal during the earlier stages of division and until the eccentricity of the mitotic figure becomes so great as to limit the size of the peripheral aster (*cf.* Conklin '94, Wilson '96). Then the centrosome, sphere and aster at the peripheral pole grow smaller than those at the opposite pole and even before the daughter cells are separated they are proportional in size to the volume of cytoplasm in the two cells, figs. 73, 90, text figs. VII–XI. Even after the separation of the daughter cells the nuclei may be entirely equal, but ultimately they also become proportional in size to the volume of cytoplasm in which they lie, and in the next division of these nuclei the chromosomes are proportional in size to the nuclei from which they come.

One may therefore construct a table of the relative sizes of various cell constituents, all of which are ultimately reducible to the volume of cytoplasm within the cell.

Volume	of the	Centrosome	is proportional	to that	of the	Sphere
"	"	Sphere	"	"	"	Aster
"	"	Aster	"	"	"	Cytoplasm
"	"	Chromosome	"	"	"	Nucleus
"	"	Nucleolus	"	"	"	Nucleus
"	"	Spindle	"	"	"	Nucleus
"	"	Nucleus	"	"	"	Cytoplasm

The size of all these cell constituents, therefore, is dependent upon the volume of the cytoplasm, and there is the best of evidence that the eccentricity of the

mitotic figure, which precedes unequal cleavage, is itself a result, rather than a cause, of cytoplasmic structure and activity. This is shown especially well in the formation of the polar bodies in *Crepidula*. The two centrosomes and asters are here absolutely equal until one pole of the spindle comes into contact with the egg membrane. Then a lobe of cytoplasm is formed over this pole and the peripheral movement of the spindle continues until the centrosome and chromosomes at the peripheral pole are thrust clear through this lobe into contact with its distal cell wall. Then the whole spindle becomes shorter and stouter, the connecting fibres being curved and bent, showing that the shortening of the spindle is due to some force entirely outside of the spindle which is propelling it against the cell wall. Such a case shows in the clearest possible manner that the eccentric position of the spindle is the result of cytoplasmic activities.

In the cleavage the same fact is apparent in every unequal division. Such divisions are preceded by an eccentricity of the mitotic figure, but this in turn is caused by active movements of the cytoplasm. In fact one may frequently be able to determine that a given cleavage will be unequal long before the spindle is formed, by the position of the nucleus during the rest. In the first quartette cells of *Crepidula* the nuclei lie in the inner angles of the cells during the rest, figs. 91, 93, and when the next spindle is formed and the nuclear membrane dissolved the entire mitotic figure moves away from the animal pole until the peripheral pole of the spindle come into contact with the cell membrane at the outer side of the cell and here the small peripheral trochoblast is separated from the large apical cephaloblast, figs. 93–96. In short the nucleus in the resting period preceding division lay entirely within the area of the future larger cell. The same phenomenon is shown in the division of the cephaloblasts (*cf.* figs. 96, 97).

The conclusion that the eccentricity of the spindle is caused by the activity of the cytoplasm is supported by the observations of other authors, particularly by Lillie's ('99, '01) work on *Unio*. The first cleavage in this animal is quite unequal yet "the spindle forms in the center of the egg in the plane already indicated by the elongation of the sphere substance. . . The entire spindle then moves directly along the prolongation of its axis, and thus parallel to the direction of elongation of the sphere substance, to one side of the egg, until the centrosome of one end comes almost into contact with the peripheral layer of protoplasm." Then the spindle again moves back toward the center of the egg, and then again toward the periphery until it finally comes to rest with its equator in the plane of the future cleavage. These movements of the spindle Lillie attributed to the orientation of the cytoplasm.

Somewhat similar oscillatory movements of the spindle have been observed by Ziegler ('95) in the living eggs of nematodes, though he did not connect them directly with equality or inequality of division. In my first paper on this subject ('94) I also called attention to the oscillatory movements of nuclei and cytoplasm during cleavage and pointed out the relation of such movements to the direction and equality of division.

In conclusion, it is obvious that in *Crepidula* and *Unio* the place of cell divi-

sion is prearranged in the cytoplasm and that in normal cell division the mitotic figure is oriented by stresses and movements within the cytoplasm which bring the spindle to rest with its equator in the plane of cleavage. The equality or inequality of cell division is therefore a function of the cytoplasm.

(*d*). *Quality of Daughter Cells.*—Finally we consider homogenous and heterogenous divisions or the differential distribution of different substances to daughter cells. In the case of both nucleus and centrosome there is every evidence that the most exact halving and distribution of their substance, not only quantitatively but qualitatively as well, occurs at every division. So far as my observations on the gasteropods go there is absolutely no evidence that centrosomes or chromosomes undergo the slightest qualitative changes as development advances.

With the cytoplasm, however, the case is quite different; there is here not only differential distribution of yolk but also of sphere substance and of different kinds of cytoplasm (*viz.* granular or hyaline.) Thus the yolk is entirely contained in the macromeres while the micromeres are wholly free from it. The sphere substance too, after the first two cleavages, is differentially distributed at every division, always passing into that daughter cell which lies nearer the animal pole. Here it slowly disintegrates and disappears and in its place a clear hyaline kind of plasma is formed (see text figs. XIX–XXV). If the sphere substance, or the plasma into which it is transformed, maintains the same kind of polarity after its transformation that it had before, there would result an aggregation of this substance or plasma in the cells lying near the animal pole. The result of this differential distribution of the sphere substance may be summarized as follows:—The first quartette contains two and one-half generations of sphere substance, *i. e.*, all the sphere substance of the first and second cleavages and one-half that of the third; the second, third and fourth quartettes each contain one generation of sphere substance, *i. e.*, one-half that of the division by which they were formed and one-half that of the preceding division. The macromeres never contain more than one-half generation of sphere substance.

Finally, in the subdivisions of the quartettes, the cells lying nearest the animal pole receive most of the sphere substance or of the plasma to which it gives rise. Since the sphere substance varies in quantity in different cells, being always proportional to the size of the cell, the distribution of the substance by generations does not give any idea of its quantitative distribution. However, the first quartette not only receives a larger number of generations of the sphere substance than any other but also a larger quantity of this substance. Associated with this may be the fact that the cytoplasm of the first quartette is always clearer and less granular than that of the second and third.

The sphere substance is formed of hyaloplasm from the cell body and achromatin from the nucleus and the differential distribution of this substance may be an important factor of differentiation. If the nucleus controls the cell as DeVries, Weismann and Roux maintain,[1] we have in this differential distribution of the spheres a possible mechanism for such control, as well as for differentitation. However, the

[1] See p. 52.

only difference in cells which I can positively associate with this differential distribution of the spheres is the more or less hyaline character of the cytoplasm.

This differential distribution of the spheres, like the distribution of the cytoplasm and yolk, is the result of the polarity of the cell contents; the mechanism of this distribution is found in the cell movements during every telophase.

It follows from these conclusions on differential cell division that the various forms of cleavage such as radial, spiral, bilateral, equal, unequal, homogeneous, heterogeneous, etc., are expressions of the activity and structure of the cytoplasm rather than of the nucleus or centrosome, and since the cytoplasm is almost exclusively derived from the egg cell while very little of it comes from the sperm we should expect that the early cleavages would be little influenced by the latter. This is just what Boveri ('92) found to be the case in eggs of *Sphærechinus* which were fertilized by *Echinus* sperm. From this cross a larval form developed which was intermediate in character between the two genera, but the cleavage was purely maternal in character, thus indicating that it was not influenced by the sperm. Driesch ('98), also, in many crosses between different species of echinids has shown that the rythm of division, the vacuolization of cells of the blastula, the configuration of the larval stages, the color, manner of swimming and the number of mesenchyme cells of the larvæ depend upon the egg cell and not upon the sperm, and therefore, in all probabilities, upon the cytoplasm and not upon the nucleus or centrosome.

On first thought such conclusions seem to be at variance with the usually accepted view that the nucleus is the bearer of inheritance and that it, together with the centrosome, are the prime movers in all formative processes. They do not, however, do more than show that in the early development inherited characteristics, like material substance, are chiefly derived from the mother. But although differentiations and inherited characteristics first appear in the cytoplasm there is good reason to believe that the structure of the latter is influenced by the nucleus through the large amount of nuclear material which escapes into the cytoplasm at every mitosis. Certainly many features of later development are derived from the father and the conclusions as to the part which the nucleus has in hereditary transmission, founded as they are upon the remarkable apparatus for such transmission afforded by the nuclei, cannot be lightly cast aside.

I have attempted to show in what manner the cytoplasm is responsible for some of the early differentiations of development; how many important features of polarity and differential cell division are caused by movements of the cytoplasm; how these movements are perhaps caused by chemotropic attractions between unlike substances; but if we go farther and inquire what directs and co-ordinates these cytoplasmic movements we cannot at present find any satisfactory answer. It may of course be said that this is due to the "structure of the cytoplasm", but this is no more than a convenient phrase to include a whole series of more or less unknown phenomena which must still be analyzed.

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EXPLANATION OF FIGURES.

All figures are camera drawings of eggs of *Crepidula plana* and, unless otherwise specified, were drawn at the stage level under Zeiss apochromatic Obj. 1.5 mm., Occ. 4. The colors used are more or less conventional, no attempt having been made to reproduce the exact coloring of the preparations ; in all cases yolk is represented in yellow and cytoplasm in neutral tint.

Reference Letters.

Am^{I}.—Amphiaster (Netrum) of the First Maturation.
Am^{II}.— " " " Second "
Am^{1}. Am^{4}.—Amphiasters of successive Cleavages.
As.—Accessory Aster.
C^{I}.—Centrosomes of the First Maturation.
C^{II}.— " " Second "
C^{1}. C^{4}.—Centrosomes of successive Cleavages.
Ch.—Chromosomes.
Ch. V.—Chromosomal Vesicle.
FS.—Fused Spheres.
H.—Head of Sperm.
M.—Middle piece of Sperm.
MG.—Middle piece Granules.
N.—Nucleus.
Nl.—Nucleolus.
Nl^{1}.—Inner Nucleolus.
S.—Sphere.
S^{1}. S^{4}.—Spheres of successive Cleavages.
T.—Tail of Sperm.
Z.—Zwischenkörper.
1a-1d.—Micromeres of the First Quartette.
2a-2d.— " " Second "
A, B, C, D.—Macromeres.

CERTAIN

ABORIGINAL REMAINS

OF THE

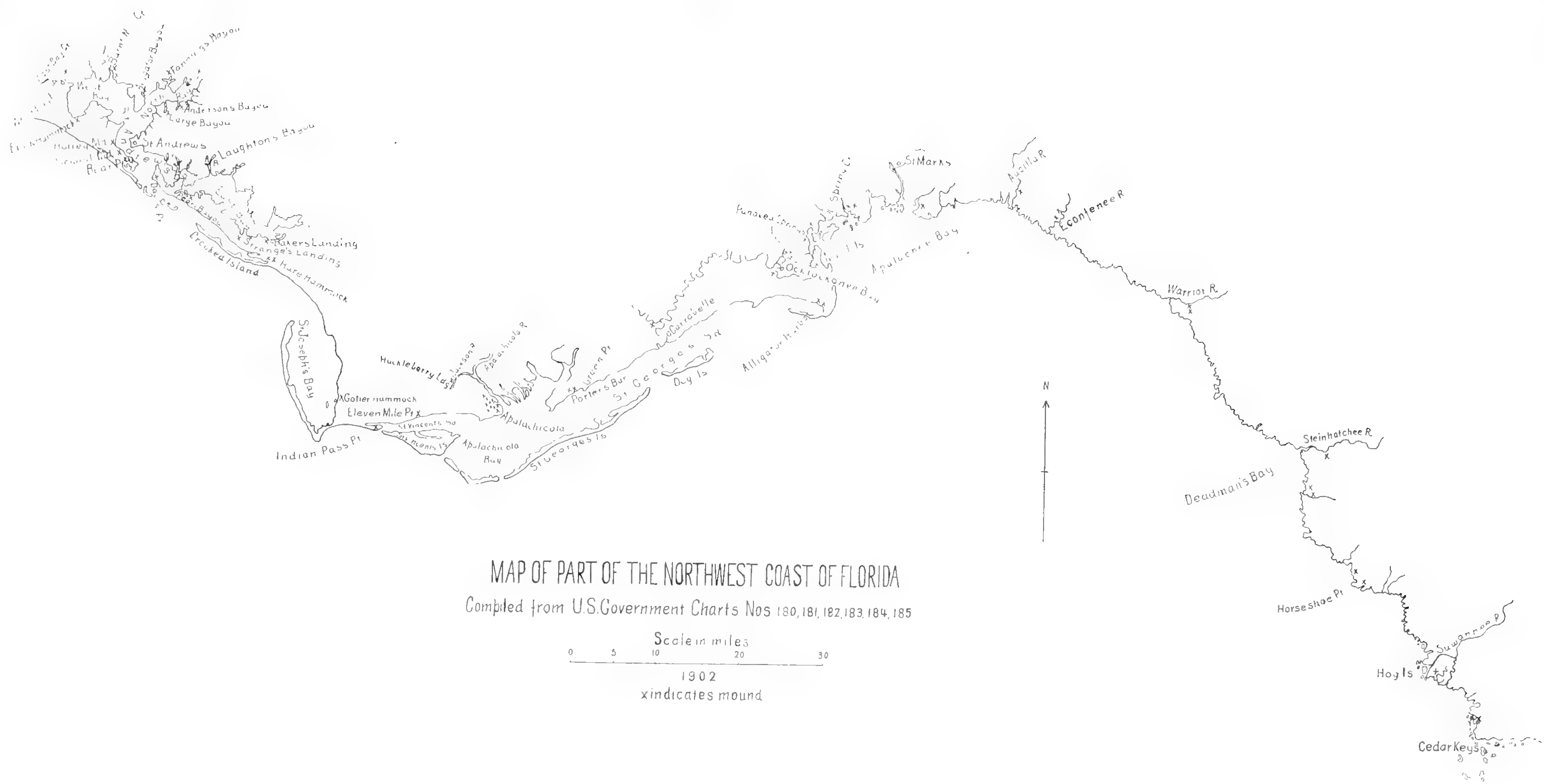
Northwest Florida Coast

PART II.

BY

CLARENCE B. MOORE.

PHILADELPHIA :
1902.



MAP OF PART OF THE NORTHWEST COAST OF FLORIDA

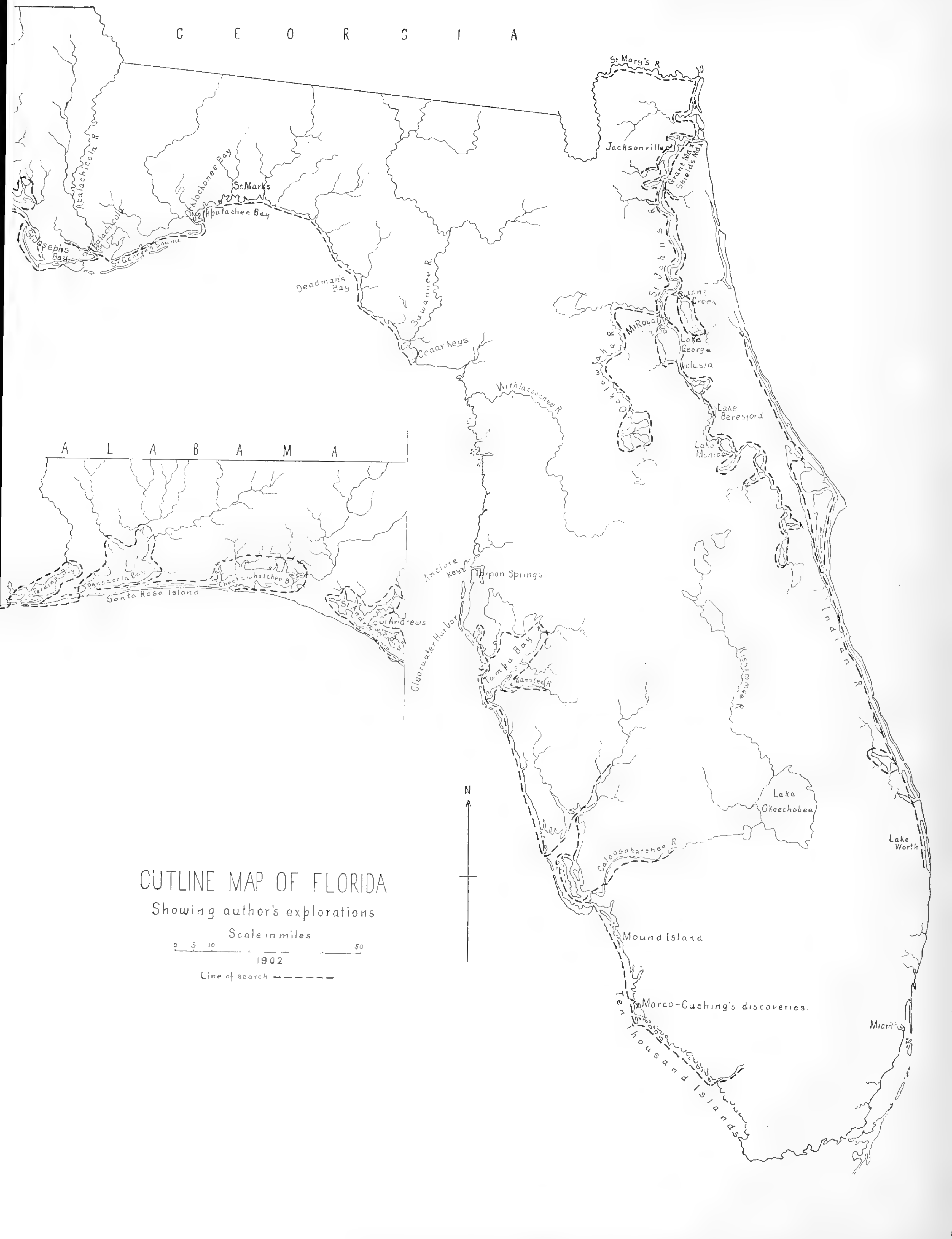
Compiled from U.S. Government Charts Nos 180, 181, 182, 183, 184, 185

Scale in miles

0 5 10 20 30

1902

x indicates mound


OUTLINE MAP OF FLORIDA
Showing author's explorations
Scale in miles
0 5 10 50
1902
Line of search
N
GEORGIA
ALABAMA
St. Mary's R
Jacksonville
Grant Md
Shield's Md
St Johns R
Dunns Creek
Mt Royal
Ocklawaha R
Lake George
Volusia
Lake Beresford
Lake Monroe
Indian R
Kissimmee R
Lake Okeechobee
Lake Worth
Miami
Caloosahatchee R
Mound Island
Marco-Cushing's discoveries.
Ten Thousand Islands
Apalachicola R
Ocklockonee Bay
St. Marks
Apalachee Bay
Apalachicola
St. George's Sound
St. Josephs Bay
Deadman's Bay
Suwannee R
Cedar Keys
Withlacoochee R
Anclote Keys
Tarpon Springs
Clearwater Harbor
Tampa Bay
Manatee R
Perdido Bay
Pensacola Bay
Choctawhatchee B
Santa Rosa Island
St. Andrews
St. Andrews B

CERTAIN ABORIGINAL REMAINS OF THE NORTHWEST FLORIDA COAST.

Part II.

By Clarence B. Moore.

In the first part of this report, of which this is the second and concluding part, we gave the result of our investigations along a portion of the northwest coast of Florida, beginning at Perdido bay, the coast-boundary between Alabama and Florida, and continuing eastward along Pensacola bay, Santa Rosa sound and Choctawhatchee bay.

In this second part we describe the result of our work going eastward and later, southward, along St. Andrew's bay, St. Andrew's sound, St. Joseph's bay, St. Vincent's sound, Apalachicola bay, St. George's sound, Alligator Harbor, Ocklockonee bay, Apalachee bay, Deadman's bay and the rivers and Gulf coast to Cedar Keys.

Mr. J. S. Raybon, captain of the flat-bottomed steamer from which our researches are always conducted, with a companion, spent a number of months previous to our visit in going over all the territory later investigated by us, locating all known aboriginal remains along our intended route. The names and addresses of owners[1] were sent to us in advance that, permission to dig being obtained previous to our visit, there might be no delay when we found ourselves on the ground. In fact, by traveling after working hours no time was wasted and the four months of the season of 1902 were taken up almost entirely in digging.

From St. Andrew's bay to Apalachee bay, inclusive, with one exception, we investigated every mound the most careful search could locate and, we believe, all that existed, save several small, flat, circular heaps in open pine woods, which experience has taught us were not intended for burial purposes, but as sites for tepees.

Along the coast between the eastern end of Apalachee bay and Cedar Keys, we investigated all the mounds that persistent search had located, but as the shore is swampy in many places and the water is shoal and often studded with masses of lime rock, access is difficult and hence inhabitants from whom inquiries as to mounds can be made are few. Therefore, it is likely some mounds escaped us, but such as were dug by us were probably representative.

We know of no previous scientific work in the district we have gone over; but

[1] Our sincere thanks are tendered owners of mounds investigated by us, who, almost without exception, gave full permission to dig.

unfortunately the mounds were not intact. Not treasure seekers alone have dug into the mounds of St. Andrew's and of Apalachicola, bays, but individuals seeking curiosities to sell, some of whom have come under our personal notice. Still, the size of the mounds in some instances has been a partial protection against a single digger, while ignorance as to where to search has often saved contents of smaller mounds.

As markedly as was the case in the first part of this report, the result of our work this season resolved itself into little more than a study of the aboriginal earthenware of the coast-district investigated by us. Lewis Morgan, sometime an honored correspondent of our Academy of Natural Sciences, has said, we believe, in his "League of the Iroquois", that the advent of earthenware marks the line between savagery and barbarism. Hence it may be considered, in view of the importance of earthenware as an aid to the study of the people, that the returns of our season's work have been sufficient.

All measurements of earthenware reported in this volume are approximate.

It must be borne in mind in respect to process work that reductions in size are made with regard to diameter and not area. If a diagram four inches by two inches is to be reduced one-half, each diameter is divided by two and the reproduction, which is called half size, is two inches by one inch. The area of the original diagram, however, is eight square inches, while that of the so-called half size reproduction is two square inches, or one-quarter the area. To find the actual size of a design shown in diagram, multiply the length and the breadth by two, if the diagram is given "half size"; by three, if "one-third size", and so on.

In a few cases partial restoration of vessels has been attempted, but always in a material differing in color from the original so that the restoration may be readily recognized, and it has been done only when the remainder of the vessel clearly indicated the size and shape of the missing part. All objects found by us, with the exception of certain duplicates sent to the museum of Phillips Academy, Andover, Mass., may be seen at the Academy of Natural Sciences of Philadelphia.

Dr. M. G. Miller, who has been with us in all our previous mound work, determined as to human remains this year and lent his assistance in a general way to all the field work and in putting this report through the press.

Mounds Investigated.

Mound near West Bay post-office, St. Andrew's bay.
Mound near West Bay creek, St. Andrew's bay.
Mound in Brock Hammock, St. Andrew's bay.
Larger Mound near Burnt Mill creek, St. Andrew's bay.
Smaller Mound near Burnt Mill creek, St. Andrew's bay.
Mound near Alligator bayou, St. Andrew's bay.
Mound near Fanning's bayou, St. Andrew's bay.
Mound near head of North bay, St. Andrew's bay.
Mound near Anderson's bayou, St. Andrew's bay.
Mound near Large bayou, St. Andrew's bay.

Holley Mound, St. Andrew's bay.
Sowell Mound, St. Andrew's bay.
Mounds near Bear Point, St. Andrew's bay (4).
Cemetery at St. Andrew's, St. Andrew's bay.
Mound at St. Andrew's, St. Andrew's bay.
Mound near Davis Point, St. Andrew's bay.
Mound near Pearl bayou, St. Andrew's bay.
Mounds near Laughton's bayou, St. Andrew's bay (2).
Mound near Strange's Landing, St. Andrew's bay.
Mound near Baker's Landing, St. Andrew's bay.
Mounds near Hare Hammock, St. Andrew's sound (2).
Mound in Gotier Hammock, St. Joseph's bay.
Mound near Indian Pass Point, St. Vincent's sound.
Mound at Eleven Mile Point, St. Vincent's sound.
Cool Spring Mound, Apalachicola bay.
Mounds near Apalachicola, Apalachicola bay (2).
Pierce Mounds, near Apalachicola, Apalachicola bay (5).
Singer Mound, near Apalachicola, Apalachicola bay.
Jackson Mound, near Apalachicola, Apalachicola bay.
Mound near Huckleberry Landing, Jackson river.
Mound near Porter's Bar, St. George's sound.
Mound near Green Point, St. George's sound.
Mound on Carrabelle river.
Tucker Mound, Alligator Harbor.
Yent Mound, Alligator Harbor.
Mound at Marsh Island, Ocklockonee bay.
Nichols Mound, Ocklockonee bay (2).
Mound near Ocklockonee bay.
Hall Mounds, Apalachee bay (2).
Mound near Spring creek, Apalachee bay.
Mound near the Mound Field, Apalachee bay.
Mound near St. Mark's, Apalachee bay.
Mound near the Aucilla river.
Mounds near the Econfenee river (2).
Mounds near the Warrior river (2).
Mound near the Steinhatchee river.
Mounds near Goodson's Fish-camp, Gulf coast (2).
Mound near Murphy Landing, Gulf coast.
Mounds near Horseshoe Point, Gulf coast (3).
Mound on Hog Island, Gulf coast.
Mound on Pine Key, Gulf coast.
Mound near the Shell-heap, Gulf coast.

Mound near West Bay Post-Office, Washington County.

About one-quarter of a mile WNW. from the village known as West Bay post-office, in a field formerly under cultivation, on property of Mr. George W. Lee of Point Washington, Florida, was a mound about 8 feet in height and 58 feet through the base. This mound, formerly a truncated cone, had been considerably dug into superficially and to a certain extent in a more serious way, but not sufficiently to disturb more than a small portion of the mound.

The mound was totally demolished by us, including its extreme marginal parts.

No interments were found until the central parts of the mound were reached and such as were met with were so badly decayed that almost no trace of them remained. Owing to this it was impossible to determine the form of interment, but a small fragment of femur, lying just beneath the crowns of certain teeth, indicated a bunched burial in that case at least.

Over certain burials, as is often seen in Florida mounds, were deposits of charcoal which cannot have been the remains of continued fires since the bones were not calcined nor the sand reddened by heat.

With one burial was a knife or arrowhead of chert; with another, a thick sheet of mica. In caved sand was a hone of ferruginous sandstone[1] and a large "celt".

Incidentally, we may say that in this report the rocks from which the "celts" discovered by us were made will not be stated. Apparently no new features were presented and in many cases these implements were given to owners of mounds, who wished souvenirs from them.

Beginning almost directly at the margin of the NE. part of the mound, on or near the base, as a rule, vessels of earthenware were met with, sometimes singly and again a number together. This deposit, continuing and broadening to the eastward, extended under the slope of the mound almost to the margin of the summit plateau, where the burials began. At times vessels and quantities of fragments of vessels lay together. These fragments, when collected, often failed to furnish full complement of the vessels to which they belonged, but as parts were found widely separated sometimes, it is likely many vessels had been broken first and then scattered through the mound while it was in process of construction, a custom we have noted in the first part of this report. An example of this practice was noticed in the case of a vessel with five compartments, which had been broken into four parts. One of these parts was met with in digging, several hours before the others which, themselves, were somewhat separated and many feet nearer the center of the mound.

As we had found the case to be before along the northwest coast, the sand in that part of the mound in which the earthenware deposit lay was much darker in color than that of the rest of the mound. During our investigations the present sea-

[1] Our thanks are tendered Messrs. Theodore D. Rand and Lewis Woolman, of our Academy of Natural Sciences, for all determinations of rocks mentioned in this report. As it was not expedient to mutilate specimens for microscopic slides, determinations have not been made with the certainty that otherwise would have been the case.

son so universal was this occurrence of blackened sand in which no particles of charcoal were apparent that a certain amount from the Hall mound, near Panacea Springs, was put aside by us and afterward submitted to Prof. Harry F. Keller, Ph. D., of Philadelphia, who, under date of June 28, 1902, reports as follows:

"The chemical and microscopic examination of the black sand from the mound at Panacea Springs, Fla., shows that the dark color is due to carbonaceous matter which is very probably of animal origin. Most of it is in the form of very minute black particles adhering to the sand. These particles show no distinct structure and are certainly not wood charcoal. When the sand is strongly heated in air, the carbon burns off, leaving a residue nearly white. The black particles are soluble to a considerable extent in caustic potash and in nitric acid, imparting a deep brown color to these solvents, an indication that organic matter is present. A few larger particles which I succeeded in picking by the aid of a lens were incinerated, and the residue gave a strong reaction for phosphoric acid. Could this matter be the product of partial charring or slow decomposition of bone?"

Dr. H. F. Keller submitted the sand to Dr. I. Keller, an expert microscopist, who concurred in the belief that the carbonaceous matter was of animal origin and stated, "I cannot think of anything in the vegetable line that could have produced this result."

Many of the vessels and parts of vessels found by us in this mound, being of ordinary form, of inferior ware and undecorated, will not be particularly described.

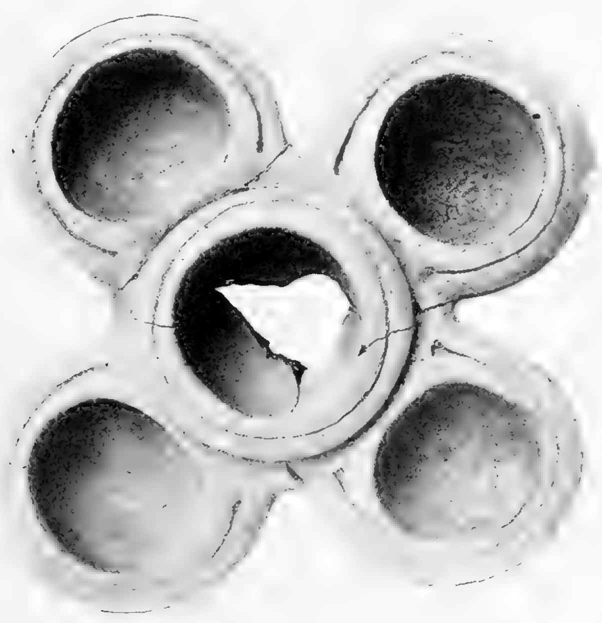


FIG. 1.—Vessel No. 1. Mound near West Bay P. O. (One-third size.)

Vessel No. 1.—In Fig. 1 is shown a vessel with five circular compartments, a central one being somewhat raised above the surrounding four. The only decoration is an incised line encircling the middle compartment and one almost surrounding each of the others. The ware is thick and of fairly good quality. The central compartment alone has the basal perforation. Maximum diameter of vessel, 9.5 inches; height, 2.1 inches. We have not met with compartment vessels of this character west of this place.

Vessel No. 2.—Fig. 2 shows an entirely new type, we believe, a combination of the compartment vessel and the life-form. The head, body and tail are represented by the outlines of the three compartments and to make the resemblance still stronger, horns or "feelers," have projected from the head. Parts of these, missing when found, have

been restored. The ware, which is thick and fairly good, has traces of crimson pigment at various points. The middle compartment only has the base-perforation. Length, 9.5 inches; height, 2 inches.

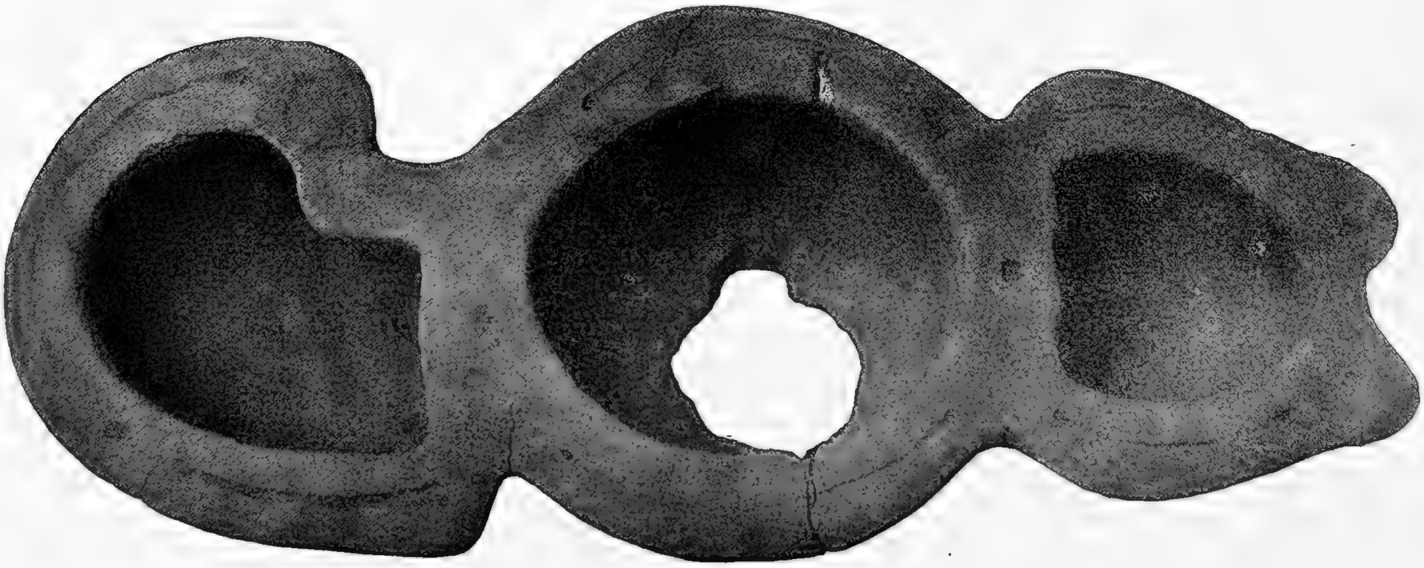


FIG. 2.—Vessel No. 2. Mound near West Bay P. O. (Three-fourths size.)

Vessel No. 3.—This vessel, shown in Fig. 3, perforate, undecorated, has a globular body and slightly expanding neck. The rim is trilateral. Height, 8.5 inches; maximum diameter, 7 inches; opening, 5.2 inches.

FIG. 3.—Vessel No. 3. Mound near West Bay P. O. (Half size.)

Vessel No. 4.—Seems to be a life-form, though the mouth is peculiarly placed in relation to the ridge on the back if this latter is intended to represent a dorsal fin. The opening has a portion missing at one side, but as the margin is unimpaired a part of the way, it is not likely much has been broken off. There are traces of crimson paint on the vessel inside and out (Fig. 4). Length, 11.2 inches; height, 6 inches; width, 6.5 inches.

Vessel No. 5.—In Fig. 5 is shown a vessel which, expanding slightly from the base upward, ends in an oblate spheroid. On the lower part of the vessel are incised encircling lines and punctate decoration. Two lines of punctate markings are below

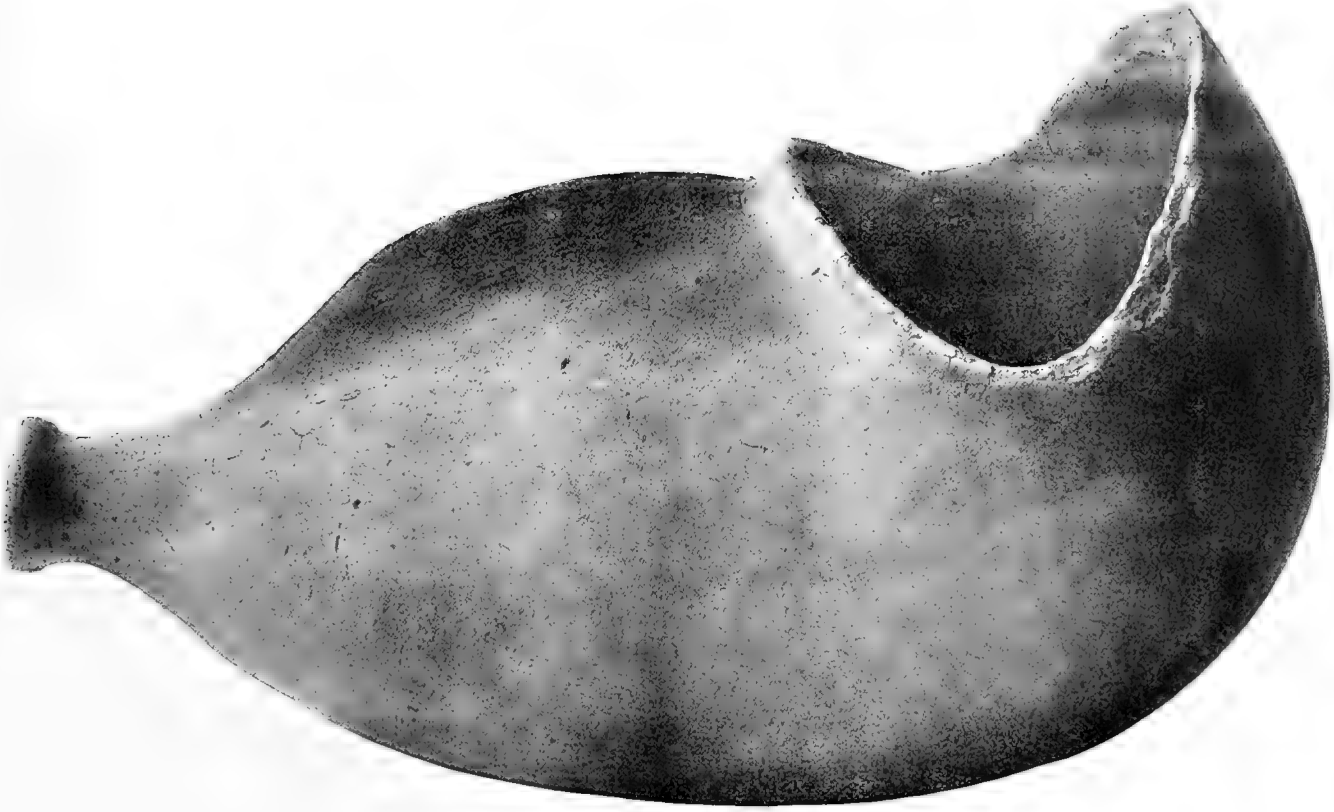


Fig. 4.—Vessel No. 4. Mound near West Bay P. O. (Three-fifths size.)

Fig. 5.—Vessel No. 5. Mound near West Bay P. O. (Five-sixths size.)

the rim. On the other side are small holes for suspension. A mortuary perforation of base is present. Height, 6 inches; maximum diameter, 5.8 inches.

FIG. 6.—Vessel No. 6. Mound near West Bay P. O. (Full size.)

Vessel No. 6.—Part of a compartment vessel of a type new to us is shown in Fig. 6. We cannot say how many divisions there have been. In the part remaining a small one is shown within another.

Vessel No. 7.—A perforate bowl is shown in Fig. 7 giving a good example of handsomely executed pinched decoration, eight rows of which surround the body. Height, 4 inches; maximum diameter, 5.8 inches.

Vessel No. 8.—An interestingly decorated vessel shown in Fig. 8 of somewhat less than 1 pint capacity. The upper part of the body is quadrilateral. The lower part tapers to what was a flat base previous to the mortuary mutilation. The rim projects horizontally with a small handle on two opposite sides.

Vessel No. 9.—A perforate bowl of rather poor ware, of about 1 gallon capacity, has below the rim four encircling rows of impressions made by a triangular point, between two incised lines.

Vessel No. 10.—The upper portion of a vessel of good ware, having below the rim incised and punctate decoration. The design, which shows an animal head with eyes, is once repeated on the vessel (Fig. 9).

Vessel No. 11.—A bowl of about 3 pints capacity, of uniform decoration, incised and punctate. A small animal head projects vertically from the rim (Fig. 10).

FIG. 7.—Vessel No. 7. Mound near West Bay P. O. (Four-fifths size.)

Vessel No. 12.—A vessel of about 1 quart capacity, in form an ovoid truncated at either end, with a flaring five-pointed rim, is shown in Fig. 11.

FIG. 8.—Vessel No. 8. Mound near West Bay P. O. (Half size.)

Vessel No. 13.—A jar of about 3 pints capacity, badly crushed when found. The fragments have been cemented together with partial restoration. The ware is inferior and the incised decoration is rude. A handle or lip projects obliquely from the rim (Fig. 12).

Vessel No. 14.—A vessel of about 3 quarts capacity, found in fragments a number of which were not recovered. The parts have been cemented together and certain restoration has been attempted. The body of the vessel has an oval transverse section; the opening is oval. From one end of the vessel projects a large head, perhaps intended to represent that of a panther. It certainly bears no resemblance to the head of a bear, of a wolf, or of an aboriginal dog. There is interesting incised and punctate decoration, in part representing conventionalized fore-legs and hind-legs (Fig. 13).

Vessel No. 15.—This vessel, of about the same shape as the one just described, was found broken to fragments from which certain parts of the vessel are missing.

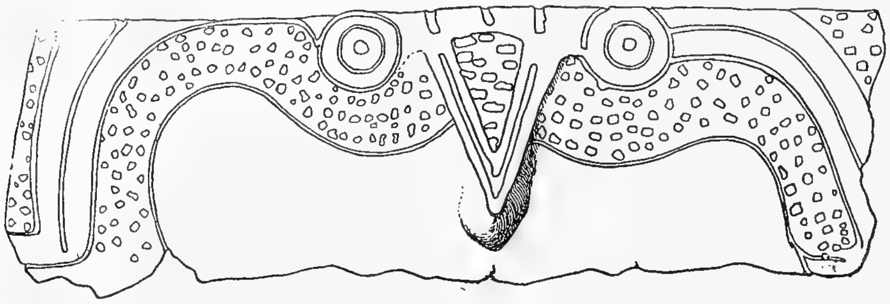


FIG. 9.—Vessel No. 10. Decoration. Mound near West Bay P. O. (Half size.)

Cementing and partial restoration show the body to have been of about 2 quarts capacity, with decoration, incised and punctate, in part representing wings. As the design varies somewhat on either side, complete restoration has been impossible. At either end is a bird's head from which the bill has been broken in part (Fig. 14). On

FIG. 10.—Vessel No. 11. Mound near West Bay P. O. (Half size.)

FIG. 11.—Vessel No. 12. Mound near West Bay P. O. (Half size.)

FIG. 12.—Vessel No. 13. Mound near West Bay P. O. (Half size.)

Fig. 13.—Vessel No. 14. Mound near West Bay P. O. (Seven-eighths size.)

FIG. 14.—Vessel No. 15. Mound near West Bay P. O. (Two-thirds size.)

this vessel are a number of symbols, perhaps representing feathers. Symbols of this class are found on practically all bird-vessels and consist of straight or curved lines with circular or triangular enlargement at one end or at both ends.

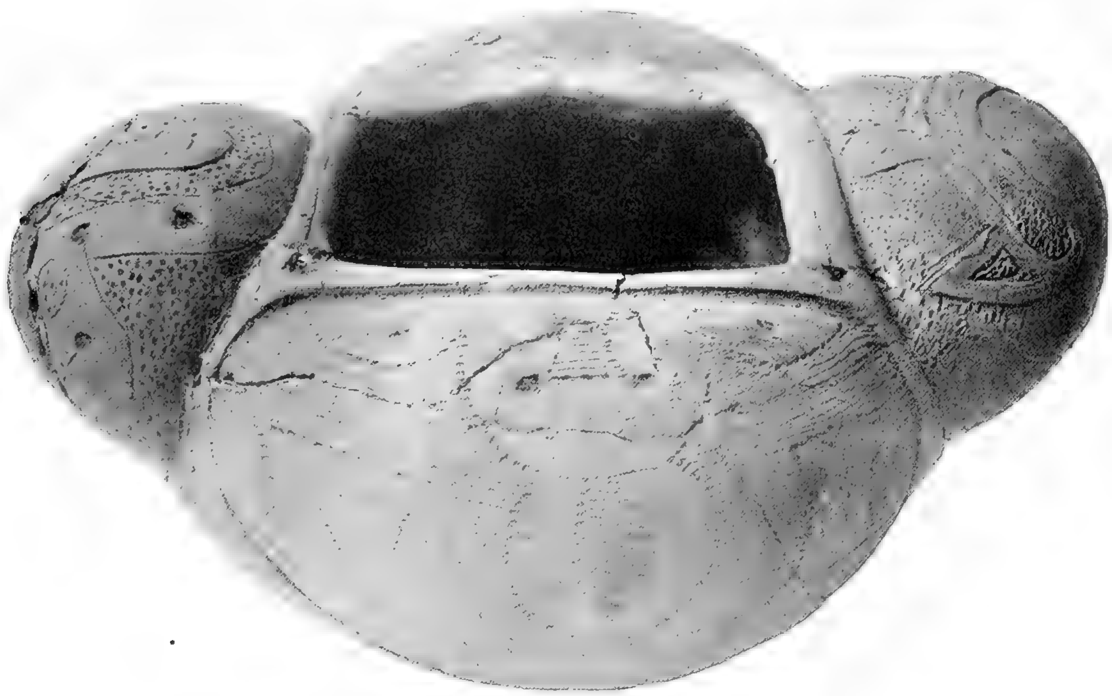


FIG. 15.—Vessel No. 16. Mound near West Bay P. O. (Two-thirds size.)

These bird-symbols are sometimes found on vessels apparently having no connection with bird forms, though they may indicate some connection with the bird. On the other hand, as Professor Holmes has shown, the aborigines were not always consistent and the bird symbol at times may have degenerated into an ornament. At all events, the symbols we have described belong normally to the bird.

Fig. 16.—Handle of vessel. Mound near West Bay P. O. (Eight-ninths size.)

Vessel No. 16 is a graceful vessel of about 2 quarts capacity found in small fragments and partly restored. Seemingly, the decoration, incised and punctate, is not uniform. This vessel, made up of four lobes, is shown in Fig. 15.

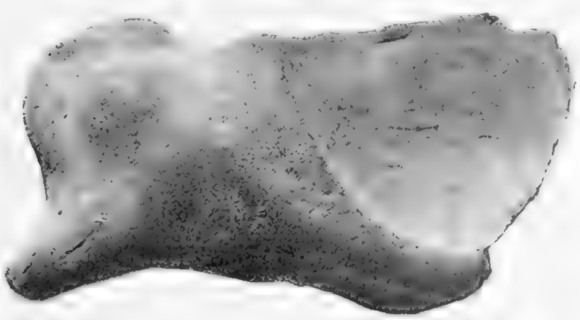


Fig. 17.—Handle of vessel. Mound near West Bay P. O. (Eight-ninths size.)

Figs. 16, 17, 18, 19 represent four bird-head handles from this mound.

On the base, in the central part of the mound, sometimes together in twos and threes, apart from burials, were sixteen vessels of ordinary type and inferior ware. Some were undecorated; some had an indistinct, complicated stamp; a few had scalloped margins. All had the basal perforation which we believe, without exception, was the case with the vessels of this mound.

These vessels, which in capacity ranged between 2 quarts and four times that amount, were so water soaked and so hopelessly crushed that all hope of saving them was abandoned.

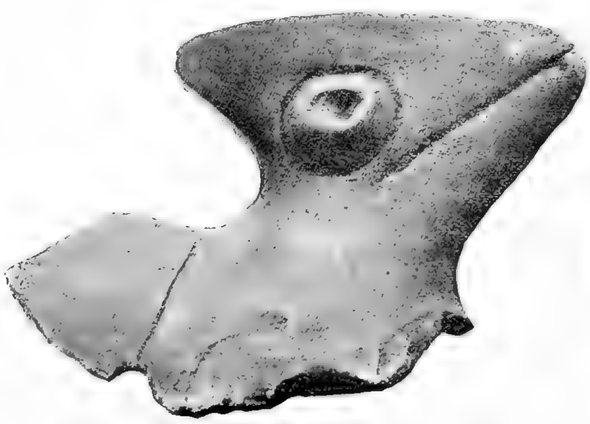


FIG. 18.—Handle of vessel. Mound near West Bay P. O. (Eight-ninths size.)

FIG. 19.—Handle of vessel. Mound near West Bay P. O. (Eight-ninths size.)

MOUND NEAR WEST BAY CREEK, WASHINGTON COUNTY.

This mound, in pine woods on property of Mr. W. M. Sowell of Point Washington, Florida, is about one-half mile in a northeasterly direction from the northern side of the western extremity of West bay, which is one of the subdivisions of St. Andrew's bay (see map). Its diameter of base was 45 feet; its height, 2 feet 9 inches. Careful investigation led to the conclusion that this mound belonged to the domiciliary class.

MOUND IN BROCK HAMMOCK,[1] WASHINGTON COUNTY.

This mound, about 2.5 feet high and 38 feet across the base, was about 3 miles in a S. direction from West Bay post-office and 300 yards, approximately, from the water, on land said to belong to the United States Government. A large excavation had been made in the center previous to our visit. Extensive trenching by us yielded a small, imperforate, undecorated bowl of poor quality and several sherds, bearing the small check stamp or the complicated variety.

Human remains, which were no doubt central, had probably fallen to the lot of the previous digger.

LARGER MOUND NEAR BURNT MILL CREEK, WASHINGTON COUNTY.

This mound, which the owner, Mr. Marion Shypes, who lives nearby, informed us had been ploughed over ten years, stood in a cultivated field on the north side of the creek about 1 mile from the mouth and 200 yards from the water, approxi-

[1] The word hammock, used by Captain Bernard Romans in the latter half of the XVIII century, in his "Concise Natural History of East and West Florida," stands for territory on which grow palmetto, oak and other woods in contradistinction to pine lands, the prairie, the swamp and the marsh. The word is widely employed in Florida.

mately. Its height was a trifle over 4 feet; its basal diameter, 50 feet. Its shape had been the usual truncated cone.

The mound, which showed no trace of previous digging, was totally demolished by us.

Human remains, which were almost reduced to the consistency of paste, were found at eleven points, beginning about 15 feet from the center and consisted of single skulls and skulls with a few long bones.

Once human remains lay near a deposit of earthenware and once a few thin sheets of mica were in association.

In this mound earthenware was met with near the margin of the northeastern side and continued in, on or near the base, singly or in larger deposits of five, seven and ten vessels together until within ten or twelve feet of the center of the mound. But two or three fragments of vessels came from other portions of the mound.

In all, 39 vessels were noted by us, though it is likely some, broken into small pieces and mixed together, were neglected in our count. Many vessels were hopelessly wrecked through the action of water on the inferior ware, while others, taken out entire, are not of a character to merit particular description.

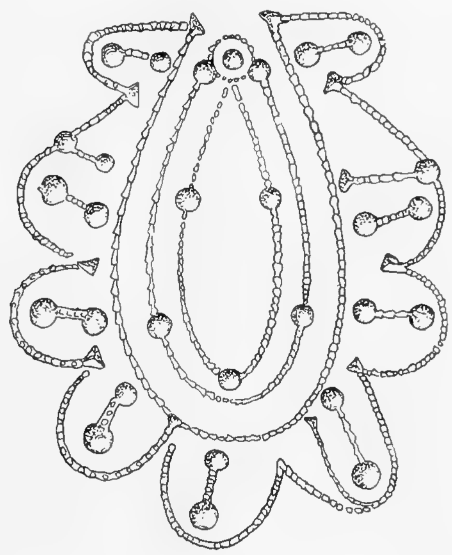


Fig. 20.—Vessel No. 4. Decoration. Larger mound near Burnt Mill Creek. (Half size.)

Vessel No. 4.—A small cup with rounded base having incised decoration on part of the body and on the base, shown diagrammatically in Fig. 20, where it has been necessary to allow a certain expansion to the design on account of its position. Hence the scale given is approximate only.

Vessel No. 5.—An undecorated jar almost cylindrical but expanding slightly at the opening. Height, 9 inches; maximum diameter, 5.7 inches.

Vessel No. 8.—About 1 quart capacity, heart-shaped in section as to the body, with constricted neck and flaring four pointed rim. The decoration, made up of encircling, undulating lines, is similar to that on Vessel No. 5 from the Hall Mound, to be described later.

Vessel No. 15.—Globular with thickened rim, undecorated, of about 2 quarts capacity.

Vessel No. 16.—A hemispherical body with slightly elongated base, part of which has been lost through mortuary breakage. The ware is yellow. The decoration consists of crosshatch design finely incised. At the corners of the spaces between the designs are imprints of a tubular implement, probably a reed (Fig. 21). Maximum diameter, 10.5 inches; present height, 5 inches; diameter of opening, 6.5 inches.

Vessel No. 18 is rather an image of earthenware, almost solid and of considerable weight. This image, representing a male wearing a breech clout, ends at the knees, apparently. The arms are folded across the chest. There are traces of crimson paint on various parts of the body. The upper part of the head, which had begun to crumble owing to the dampness of the mound, received, in addition, a blow from a spade (Fig. 22).

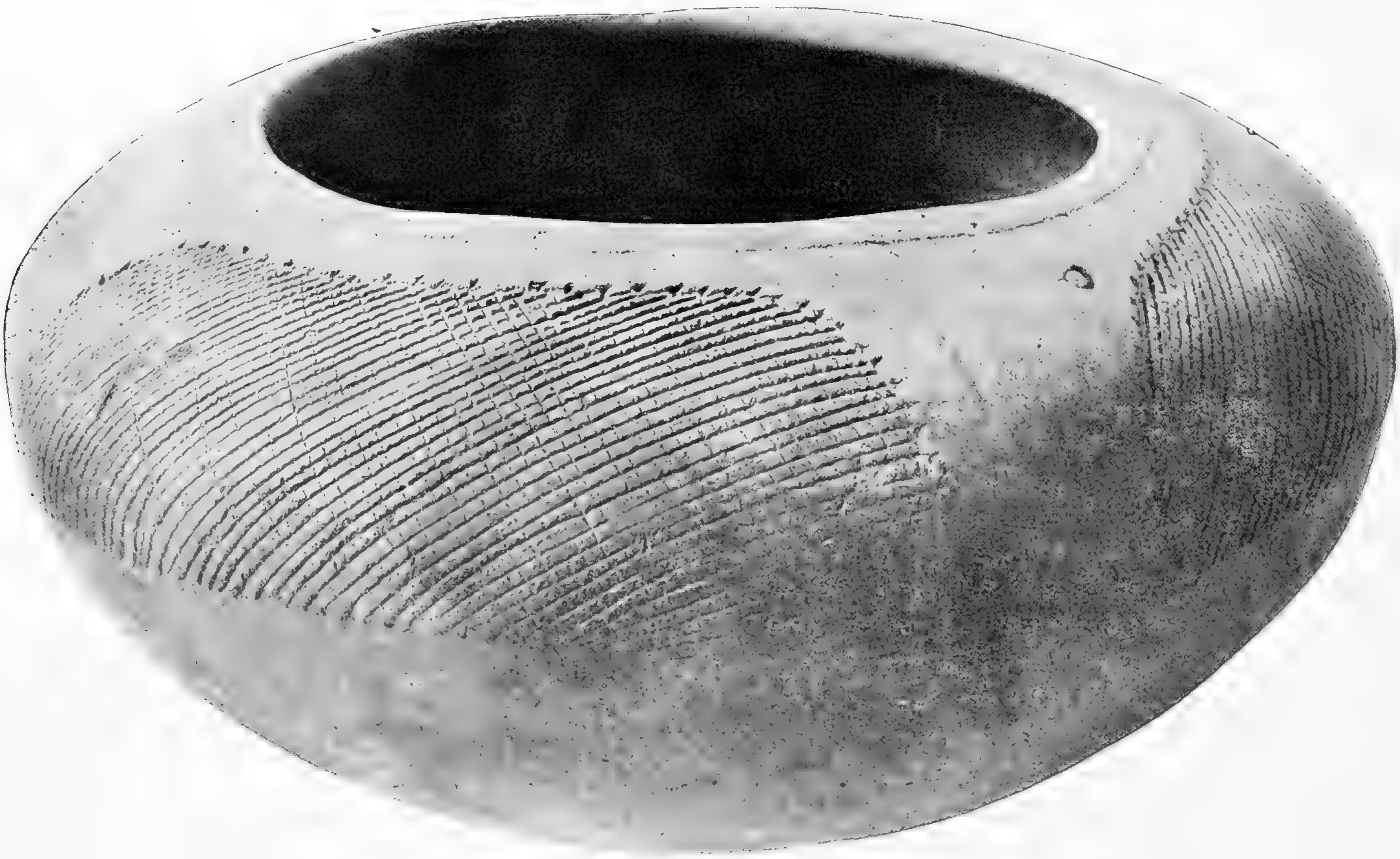


FIG. 21.—Vessel No. 16. Larger mound near Burnt Mill Creek. (About two-thirds size.)

Vessel No. 27.—Of about 1 quart capacity with a body heart-shaped in outline and a neck flaring slightly. The decoration consists of four encircling rows of punctate impressions above an incised line.

Vessel No. 31.—Seemingly, when found, a solid full-length image of the human form which, on removal, fell into an infinite number of small bits of the consistency of paste. These, on drying, became extremely friable and past all hope of restoration.

Vessel No. 32.—This most interesting vessel of the readymade mortuary type, was found in fragments which have since been cemented together with great care and a few missing portions restored, including the upright rim, as to the original shape

of which we are uncertain. The ware is thin and covered with crimson pigment. In addition to the hole in the base, made before baking, there are many other orifices, varying in size and shape, made at the same time as the basal perforation, inaugurating a type not found by us to the westward, and but infrequently met with until much farther east along the coast. At either end of the body, which has an elliptical transverse section, probably modelled after the body of a bird, is a bird's head projecting horizontally outward. Below, on one side, a hole has been made with the outline of a wing, which design is not repeated on the opposite side (Fig. 23). Length, 9.5 inches; width, 5.5 inches; height, 9 inches.

FIG. 22.—No. 18. Image of earthenware. Larger mound near Burnt Mill Creek. (Three-fourths size.)

Vessel No. 33.—A bowl, oblate spheroid in shape, much flattened, of about 3 quarts capacity, with incised decoration, half of which is shown diagrammatically in Fig. 24, the other half being similar. This vessel, found crushed to bits, has been cemented together and somewhat restored.

Vessel No. 34.—This vessel, found crushed to fragments, parts of which were not recovered, has had a flat base, most of which is now missing through the mortuary mutilation common to the vessels of this mound. The lower part, a truncated cone reversed, supports the body which is made up of three projecting bosses surmounted by incised lines. The neck slopes inward slightly (Fig. 25). Height, 8 inches; maximum diameter, 6.5 inches.

Vessel No. 35.—A quadrilateral vessel of about 1 pint capacity, tapering to the base, part of which has been knocked out. Two sides are undecorated. Of the other two sides, which have incised decoration, one is shown in the representation of the vessel (Fig. 26); the other, diagrammatically in Fig. 27.

Vessel No. 39.—A jar of about 1 quart capacity with semiglobular body and neck first slightly constricted, then flaring. The decoration, which is between two

FIG. 23.—Vessel No. 32. Larger mound near Burnt Mill Creek. (Nine-elevenths size.)

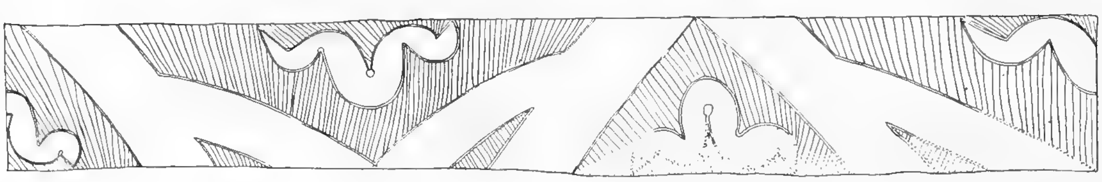


FIG. 24.—Vessel No. 33. Decoration. Larger mound near Burnt Mill Creek. (One-third size.)

FIG. 25.—Vessel No. 34. Larger mound near Burnt Mill Creek. (Nine-tenths size.)

incised encircling lines, is made up of linear impressions around the neck, six deep in places, in others, seven.

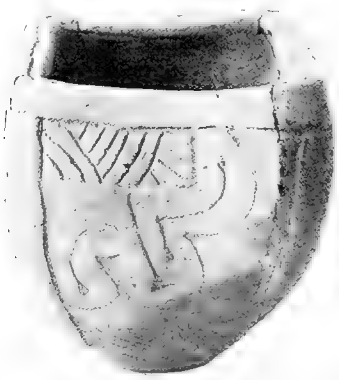


FIG. 26.—Vessel No. 35. Larger mound near Burnt Mill Creek. (Half size.)

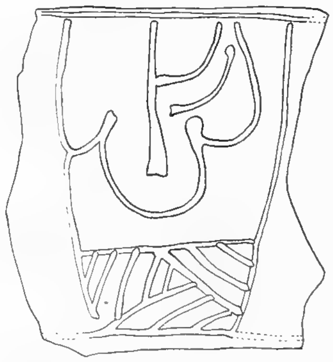


FIG. 27.—Vessel No. 35. Decoration. Larger mound near Burnt Mill Creek. (Half size.)

SMALLER MOUND NEAR BURNT MILL CREEK, WASHINGTON COUNTY.

The mound, said to be on property belonging to the State of Florida, is on ground formerly cultivated, about 1 mile in a northerly direction from the mouth of Burnt Mill creek. This mound, which was leveled by us, had a basal diameter of 28 feet; a height of about 2.5 feet. A hole in the center dug prior to our coming, involved about one-quarter of the mound. If human remains had been spared by decay, they must have occupied this central space as no trace of bones was met with by us. Nor was charcoal present or blackened sand.

FIG. 28.—Sherd. Smaller mound near Burnt Mill Creek. (About two-thirds size.)

Near the margin of the NE. part of the mound, continuing in under the sloping portion, was a deposit of earthenware vessels all within an area not over 7 feet in diameter and, as a rule, in, or almost in, actual contact, many being crushed one into the other. Of these, 29 vessels were recognized as whole or having been entire or nearly so before they were crushed by weight of sand. In addition to our count, however, must be included many other vessels hopelessly broken to small fragments and intermingled. These vessels, with four exceptions, were bowls, pots and jars, of ordinary type from 1 pint to 2 gallons capacity, approximately, mostly of thin and inferior ware which a long period of soaking had reduced to a sodden condition, unable to withstand the pressure of surrounding sand. A few vessels, however, were of somewhat better quality.

Certain of these vessels had a complicated stamp decoration more or less faint and one, encircling rows made up of oblong imprints about .75 of an inch in length. One had decoration of crimson paint interiorly while others were undecorated. All whose condition allowed determination were noted as having the usual basal perforation, with the exception of a small jar of coarse ware. Certain sherds had circular punctate decoration and one had scroll work deeply incised (Fig. 28).

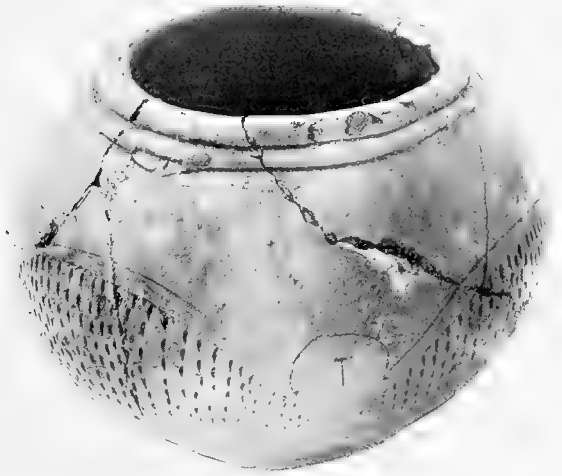


FIG. 29.—Vessel of earthenware. Smaller mound near Burnt Mill Creek. (Half size.)

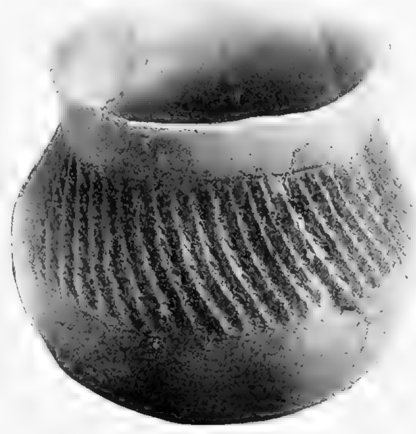


FIG. 30.—Vessel of earthenware. Smaller mound near Burnt Mill Creek. (Half size.)

Of vessels found outside the usual run, one undecorated, and of fairly thick ware, is boat-shaped with projections at the extremities.

A vessel of about 1 quart capacity has a spherical body with elongated base. Below the rim is an incised line. There have been four small projections, like rudimentary handles, one on each side a little below the rim, two of which are missing. The decoration is incised and punctate (Fig. 29).

Fig. 30 shows a vessel of about 1 pint capacity, with decoration made with an implement though such decoration is often considered cord-marked.

A sherd with complicated stamp is shown in Fig. 31.

FIG. 31.—Sherd. Smaller mound near Burnt Mill Creek. (Half size.)

Among the farthest in was a bowl of fairly good ware which pressure of sand had split. This bowl, which lay on its base, still kept an upright position. Standing in the bowl and to a certain extent protected by it, was a rude effigy-vessel of yellow ware, representing a male figure, shown in two positions in Figs. 32, 33. The lower part is wanting through the usual basal mutilation. Present height, 7.5 inches; maximum width, 4.4 inches.

A broken arrowhead or knife, of chert, lay unassociated in the sand.

FIG. 32.—Effigy-vessel, front view. Smaller mound near Burnt Mill Creek. (About full size.)

Fig. 33.—Effigy-vessel, rear view. Smaller mound near Burnt Mill Creek. (About full size.)

MOUND NEAR ALLIGATOR BAYOU, WASHINGTON COUNTY.

Alligator bayou joins North bay, a part of St. Andrew's bay on the W. side, about 2 miles up the bay.

The mound, near the head of the bayou which is about one-half mile in length, was on the property of Mrs. Elizabeth J. Daniels, who lives on the place. The mound on low-lying ground and partly surrounded by not far distant water, was very moist as to the sand composing it and in a condition to facilitate decay. It was oblong in shape, 76 feet E. and W. through the base and 50 feet N. and S. Its height was 6 feet 5 inches. It had received but little previous attention from the treasure seekers of the bay. The mound was completely levelled by us.

FIG. 34.—Vessel No. 15. Mound near Alligator Bayou. (Half size.)

Owing to the dampness, no doubt, no trace of human remains was met with by us.

At one place, in a mass of sand of almost inky blackness from admixture of organic matter, was a wooden object resembling a tine of a stag's antler, overlaid with copper. This interesting object, which doubtless accompanied a burial, unfortunately received a blow from a spade.

In another portion of the mound was a pocket of sand made crimson from admixture of hematite. This deep-colored sand called to mind the great deposits at various points in the mound at Mt. Royal described in our reports on the St. John's River Mounds, the rich crimson color differing considerably from the pink tint found in sand having the usual slight admixture of the red oxide of iron.

A barbed arrowpoint of chert, a sheet of mica to which had been given, rather rudely, the outline of an arrowhead and a shell drinking cup were the only other artifacts in the mound, exclusive of earthenware.

About 13 feet in from the margin, on the eastern side of the mound, in sand,

which by its dark admixture of organic matter, contrasted with the yellow sand of other parts of the mound, began a deposit of earthenware, 4 feet across, which, continuing in, on or near the base, broadening to the N. and S., and contracting again, ended about 11 feet from the center, thus having a length of about 14 feet.

The vessels, of which we counted sixty-six, and doubtless some badly crushed and intermingled were left from the score, were upright or tilted at almost any angle, and nearly always in groups crushed into each other or separated by very

FIG. 35.—Vessel No. 24. Mound near Alligator Bayou. (About seven-eighths size.)

small space. All but two, which will have reference later, had the usual basal perforation, at least all whose condition allowed us to determine.

Greatly to our disappointment, the vessels, which in size ranged from a toy bowl holding hardly more than a thimble-full to pots of at least four gallons capacity, were almost exclusively kitchen ware of ordinary shapes and of flimsy material. The majority were undecorated. On but two were incised designs. One vessel was covered with crimson pigment. Many vessels had the complicated stamp but, as a rule, the impress was faint though several patterns new to us were present in the

mound. The small check stamp was absent. Scalloped margins abounded. The condition of most of this pottery, thin and of inferior ware, ground together by pressure of sand after continued soaking for a long term of years, can well be imagined. In most cases our efforts to preserve the fragmentary vessels was baffled, while but few of those saved merit special mention.

Vessel No. 5.—A globular undecorated body of about 1 pint capacity with part of what had been a solid handle projecting upward at an angle. This vessel is of the class modelled after gourds.

Vessel No. 15.—A globular body of yellow ware, which probably had a flat base. Almost the entire neck, which was flaring, is missing through an old fracture. The decoration, incised, is made up of a series of two concentric circles surrounded by other designs as shown in Fig. 34. Maximum diameter, 8.2 inches.

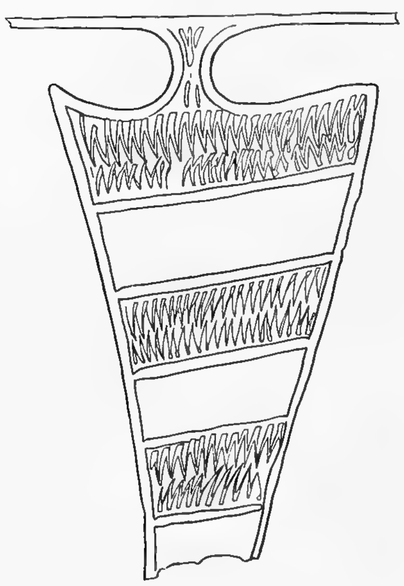


Fig. 36.—Vessel No. 24. Decoration. Mound near Alligator Bayou. (Half size.)

Vessel No. 24.—Of yellow ware, almost semi-globular body, tapering somewhat at the base. The rim flares slightly. The interesting incised decoration consists of two large similar designs on opposite sides, one of which is shown in Fig. 35. There are two smaller designs, also alike, one of which is given in diagram, Fig. 36. Maximum diameter, 7 inches; height, 5.5 inches.

Vessel No. 34.—A small vessel almost a perfect globe, with small aperture and slightly projecting rim. This vessel, of about a pint capacity, when removed from the wet sand was of a bright crimson which faded when dry.

Vessel No. 35.—A pot of yellow ware with scalloped margin. The decoration, a complicated stamp, is distinctly impressed (Fig. 37). Height, 10 inches; maximum diameter, 9 inches.

Vessel No. 44.—Badly crushed, had four small feet.

Vessel No. 64.—A pot of yellow ware expanding slightly toward the rim, which is scalloped. The decoration is a zigzag stamp identical with that shown on a sherd from this mound. Maximum diameter, 10 inches; height, somewhat impaired by loss of the base, 9.8 inches.

Vessels Nos. 65 and 66.—Toy bowls, 2.3 inches and 1.8 inches in diameter, respectively, found together a little apart from the main deposit.

Three sherds with complicated stamp decoration are shown in Figs. 38, 39, 40.

Mound near Fanning's Bayou, Washington County.

Fanning's bayou joins North bay from the north about five miles up the bay.

The mound, which had been dug into to a small extent only, was on the edge of a hammock, about one mile in a NW. direction from Anderson P. O., which is

FIG. 37.—Vessel No. 35. Mound near Alligator Bayou. (Half size.)

FIG. 38.—Sherd. Mound near Alligator Bayou. (Half size.)

FIG. 39.—Sherd. Mound near Alligator Bayou. (Half size.)

about two miles up the bayou. The mound was about 3 feet high and about 40 feet in basal diameter. The ownership of the property is in dispute.

The mound, which was totally demolished by us, contained nineteen burials, single skulls with a few long-bones, or long-bones without skulls, or in two cases, two skulls with long-bones. Above certain of these burials was charcoal.

With one burial was a shell drinking cup. Another burial lay near certain vessels of earthenware, but as these vessels were a continuation of a deposit beginning at a considerable distance from the remains, we do not believe the earthenware had any direct connection with them.

Fig. 40.—Sherd. Mound near Alligator Bayou. (Half size.)

An arrowhead of chert and two rude imitations of spearheads in mica were found, not in immediate association with the dead.

The result of our investigation in this mound was the old story with which we have become so familiar. In the extreme margin of the eastern part of the mound, preceded by a deposit of miscellaneous sherds and continuing at intervals to the center, were numerous vessels, broken and whole, undecorated in the main, some having the small check stamp, others incised and punctate decoration. Three vessels only had the complicated stamp and that around the neck alone. A complicated stamp decoration on a sherd is shown in Fig. 41.

Fig. 41.—Sherd. Mound near Fanning's Bayou. (Three-fourths size.)

All vessels, broken or whole, as far as we could determine, had the usual base-perforation and all lay in masses of sand far darker than the yellow sand of the rest of the mound.

We shall now describe in detail the more interesting vessels from the mound, some of which, taken out in pieces, have been carefully cemented together.

Vessel No. 1.—A vessel of about 3 pints capacity has a circular neck, flaring into a square outline at the rim. The incised decoration, which is repeated on the opposite side with but slight variation, is shown in Fig. 42.

Vessel No. 2.—A bowl of curious outline recalling that of a horseshoe were the extremities joined. The body is undecorated. Notches extend around the margin of the curved portion, while an incised line resembling the symbol of the bird, which, seemingly, is not always confined to bird-vessels, stretches across the straight portion (Fig. 43).

Fig. 42.—Vessel No. 1. Mound near Fanning's Bayou. (Half size.)

Vessel No. 3.—A gracefully made semiglobular vessel with short, upright, rounded rim, of excellent ware, has four encircling lines of punctate markings around the upper part of the body, about 1 inch apart. Maximum diameter, 10.5 inches; height, 6.5 inches.

Vessel No. 4.—A jar of inferior ware (Fig. 44), 6 inches in maximum diameter with a present height of 9 inches, bears a curious punctate and incised decoration, probably some highly conventionalized figures among which may be recognized the symbol of the bird. The decoration is shown diagrammatically in Fig. 45.

Vessel No. 5.—A bowl of yellow ware of about 1 quart capacity with rude line and punctate decoration as shown in Fig. 46.

Vessel No. 6.—A vase roughly globular as to the body with neck flaring outward and upward. Where the neck joins the body on the outside are two encircling rows of pinched decoration (Fig. 47). Maximum diameter, 7.5 inches; height, 5.5 inches.

Vessel No. 7.—In the central deposit was a curious vessel of thick ware rather carelessly made, the upper portion leaning to one side. On the upper part of the vessel is punctate decoration. There are two holes for suspension (Fig. 48). Height, 7 inches; maximum diameter, 5.8 inches.

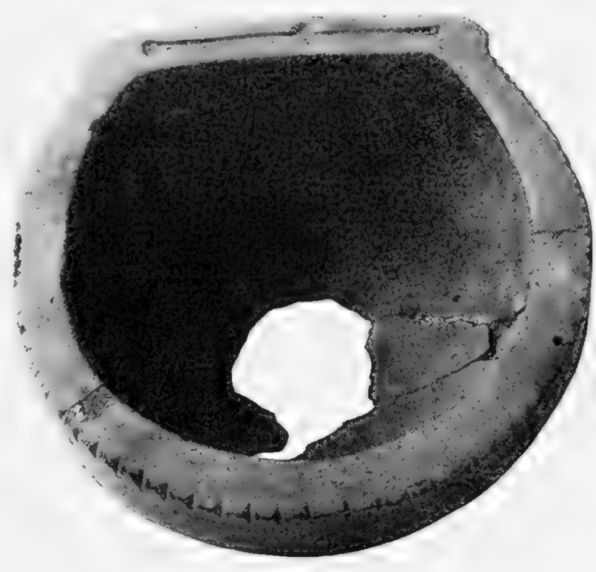


Fig. 43.—Vessel No. 2. Mound near Fanning's Bayou. (Half size.)

Vessel No. 8.—A vase of yellow ware of about 1 quart capacity, found broken into many pieces, a few of which, not

recovered, have since been restored (Fig. 49). The decoration, incised, is carefully executed. One-half of it is shown diagrammatically in Fig. 50, the other half being a repetition.

FIG. 44.—Vessel No. 4. Mound near Fanning's Bayou. (Half size.)

Vessel No. 9.—A bowl of inferior ware, about 1 quart capacity, has a cross-hatch design rudely executed. An upright protuberance about .25 of an inch in height, projects from the rim on one side.

Vessel No. 10.—This vessel, of rather soft yellow ware, found badly crushed with certain parts missing, presumably, since the sand was carefully sifted, would hold about 3 quarts. The lower part is semiglobular, slightly flattened at the base. The upper part of the body is hexagonal. The neck expands slightly. The decoration consists of six semicircles over curious incised designs varying but slightly one from another, in fields of punctate markings. Impressions of points fill the spaces between the junction of the ends of the semicircles and the neck (Fig. 51).

Vessel No. 11.—A jar of graceful outline, unfortunately much broken at the base, bearing the check stamp decoration (Fig. 52). Present height, 14.5 inches; maximum diameter, 7.5 inches.

Vessel No. 12.—A bowl with quadrilateral rim bearing incised and punctate decoration as shown in Fig. 53.

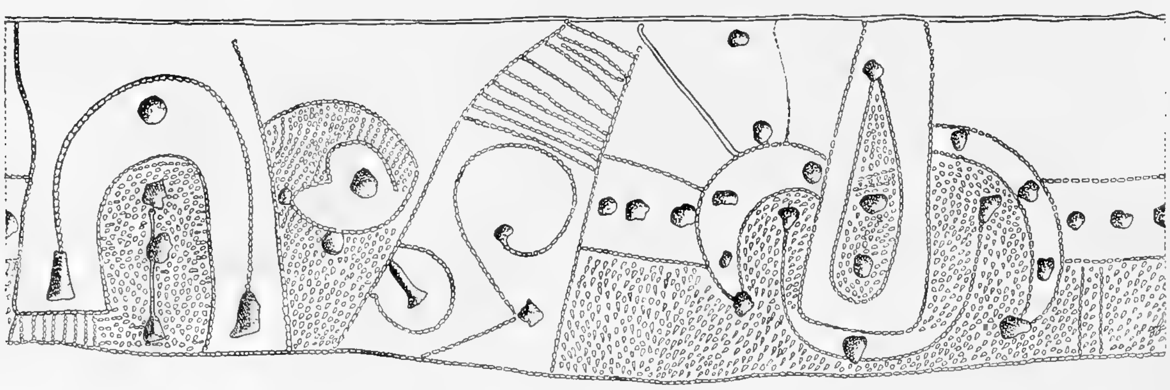


FIG. 45.—Vessel No. 4. Decoration. Mound near Fanning's Bayou. (One-third size.)

FIG. 46.—Vessel No. 5. Mound near Fanning's Bayou. (Half size.)

FIG. 47.—Vessel No. 6. Mound near Fanning's Bayou. (Half size.)

FIG. 48.—Vessel No. 7. Mound near Fanning's Bayou. (About three-fourths size.)

FIG. 49.—Vessel No. 8. Mound near Fanning's Bayou. (Full size.)

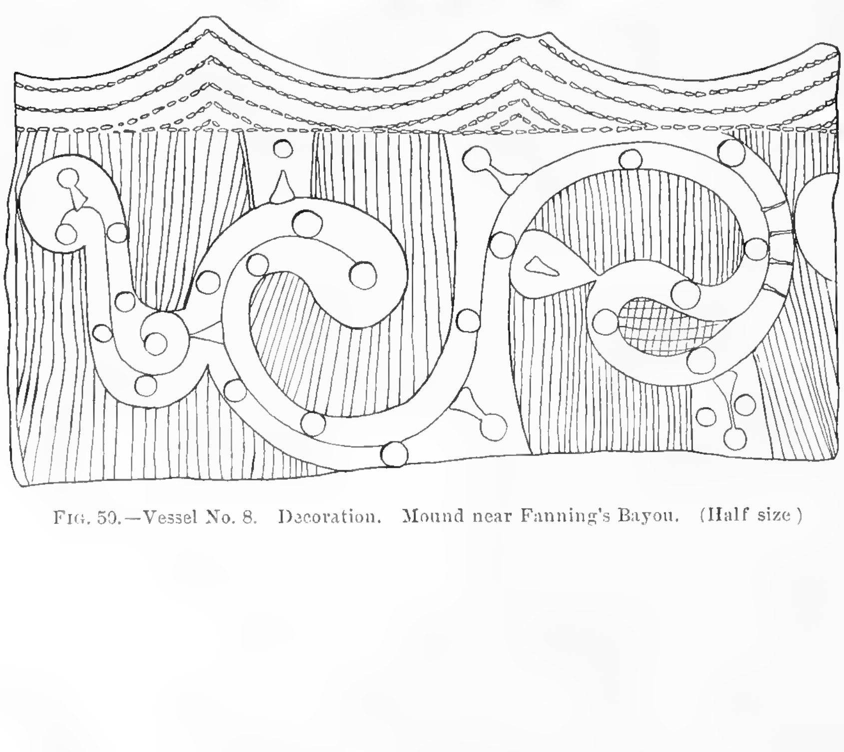


FIG. 50.—Vessel No. 8. Decoration. Mound near Fanning's Bayou. (Half size.)

FIG. 51.—Vessel No. 10. Mound near Fanning's Bayou. (Half size.)

FIG. 52.—Vessel No. 11. Mound near Fanning's Bayou. (One-third size.)

FIG. 53.—Vessel No. 12. Mound near Fanning's Bayou. (Half size.)

MOUND NEAR THE HEAD OF NORTH BAY, WASHINGTON COUNTY.

This mound, seemingly intact, was in pine woods about one-half mile in a WSW. direction from the home of Mr. W. M. Brooks, the owner, on the shore near the head of North bay.

The mound, about 2 feet in height and 38 feet across the base, was entirely dug through by us.

Human remains were met with in sixteen places and consisted of single skulls, skulls with long-bones, etc. No artifacts lay with the burials.

Unassociated, was an arrowpoint or knife, of red chert and, near the surface, lay a cube of lead sulphide about 2.5 inches in each of its dimensions.

Vessel No. 1 was met with at the extreme verge of the NW. side of the mound. The body is rounded, the rim flares slightly. The ware is most inferior. This vessel, which has four feet and faint traces of decoration, is without the basal perforation.

In the margin of the eastern part of the mound were numbers of sherds, several of good ware, many bearing the small check stamp. Among these, several feet apart, were portions of a dish of excellent ware, undecorated. In common with all the vessels in this mound, except the one first described, it had the basal perforation.

Vessel No. 3.—Triangular, with rounded corners, with slight traces of punctate and incised decoration. A handle fastened by pressure on the clay before baking is missing and was not present with the vessel. Length, 4.5 inches; height, 2 inches.

Ten other vessels were in the same deposit, all within a few feet of each other. Some were broken; all were of ordinary form, without decoration or with a rude check stamp, or, in one case, with rough incised lines.

There was no central deposit in this mound, but considerably farther in than the vessels just noted were two others, or parts of them, in fragments. Their decoration, seemingly, was conferred by basket work.

Mound near Anderson's Bayou, Washington County.

Anderson's bayou joins the E. side of North bay about 5 miles up. The mound, on property belonging to Mr. A. J. Gay, whose home is not far distant, is in thick hammock about 50 yards from the eastern side of the bayou and about one-quarter of a mile up. The height of the mound was 2 feet 4 inches; its basal diameter, 55 feet. The mound, into which three comparatively small holes had been dug prior to our visit, was completely leveled by us. It proved to be of yellow sand, except in the neighborhood of earthenware, where the sand had the customary darkened appearance.

Presumably, human remains to a certain extent had disappeared through decay as burials were found in four places only. These consisted of three skulls, together; certain small pieces of a skull; a skull with a few pieces of long-bone; and several fragments of long-bones without a skull. There were also in the mound a few bits of calcined bone, but none of a size large enough to determine whether they were human or otherwise.

There were present in the mound, unassociated with human remains, though bones may have decayed in their immediate vicinity: a bead of red argillite, nearly cylindrical, .85 of an inch in length and .55 of an inch in maximum diameter; two small fragments of sheet copper, near the surface; a sheet of mica; four bits of rock together. In association were bits of rock, pebble-hammers, smoothing stones, broken hones, four bits of *Fulgur;* a pebble with a semicircular space worn in the side, and numerous pebbles.

We have frequently found in the mounds round or cylindrical pebbles seemingly too small for use as pebble-hammers. These pebbles, often lying together as though at one time deposited within a receptacle, we believe to have been sling-stones. Cabeça de Vaca[1] says the Indians began "to throw clubs at us and to sling

[1] Chapter X, p. 37. Buckingham Smith's translation.

stones." In the original Spanish the words "*tirar piedras cō hondas*" are used, so there can be no doubt as to the meaning of the author.

Two bits of pottery with small check stamp were in the body of the mound.

In the margin of that part of the mound embraced between NE. and S. of E.,

FIG. 54.—Vessel of earthenware. Mound near Anderson's Bayou. (About four-fifths size.)

the usual deposit of pottery, made for the dead in common, began and continued in, at intervals, to the center of the mound. The vessels, which lay along the base and were unassociated with burials, all had, as far as noted, the usual basal perforation. Many were badly crushed and the ware of nearly all was most inferior. With two

exceptions, no incised decoration was present in the mound, all other vessels being undecorated, or bearing the complicated stamp.

A feature in the mound was the presence of a number of bases of vessels lying unassociated, which showed that the knocking out of basal portions in fulfilment of the mortuary rite was sometimes attended to at the mound and the bases scattered throughout the sand.

A quadrilateral vessel, with sides tapering somewhat to the base, which is flat, has a decoration similar on each side, shown in Fig. 54. Height, 9 inches; maximum diameter, 7 inches.

With the vessel just described, which came almost exactly from the center of the mound, was another with decoration of broad, incised lines, shown in Fig. 55.

Three sherds with complicated stamps are shown in Figs. 56, 57, 58; also a vessel with the same type of decoration, which we believe came from this mound, though the label formerly upon it has disappeared (Fig. 59).

Fig. 55.—Vessel of earthenware. Mound near Anderson's Bayou. (Half size.)

Fig. 56.—Sherd. Mound near Anderson's Bayou. (Four-fifths size.)

Fig. 57.—Sherd. Mound near Anderson's Bayou. (Four-fifths size.)

FIG. 58.—Sherd. Mound near Anderson's Bayou. (Four-fifths size.)

FIG. 59.—Vessel of earthenware. Mound near Anderson's Bayou. (Six-sevenths size.)

MOUND NEAR LARGE BAYOU, WASHINGTON COUNTY.

Large bayou unites with North bay about 3 miles up, on the E. side of the bay. The mound, on property of Mr. A. J. Gay, owner of the Anderson's bayou mound, is in an old field about one-half mile in a southerly direction from the head of the bayou.

This mound, about four feet high and fifty feet across the base at the present time, has been dug into for years and objects of interest are reported to have been taken from it. Much of the remainder was dug down by us.

Ten bunched burials were met with, one having two skulls.

On the base, below human remains, well in on the western slope of the mound, was a quadrilateral vessel with incised decoration similar on each side. Maximum diameter, 5.4 inches; height, 3.3 inches.

Near a burial was a considerable number of sherds, probably a vessel crushed to fragments.

Also with a burial was an undecorated toy pot, having a perforation of the base, as had all vessels found by us in this mound.

Well in on the western side, on the base, together, both badly crushed, were a pot with a complicated stamp decoration and an undecorated bowl, also mica. No bones were present with these, but presumably a burial had disappeared through decay.

At the very verge of the eastern part of the mound, with no bones associated, were a number of vessels extending in and over toward the NE. These vessels, pots and bowls, were undecorated or bore the small check stamp. Many were badly crushed. It is impossible to say how far into the mound this deposit may have extended, owing to the great amount of previous digging.

There were also in the mound portions of two compartment vessels; a pebble-hammer and a smoothing stone.

Holley Mound, Washington County.

This mound, about two miles in a westerly direction from Bear Point, in an old field, the property of Mr. John C. Holley, who lives on the place, is about 100 yards from the water. According to Mr. Holley the mound had sustained no previous digging, with the exception of two small holes dug by members of his family, which yielded nothing except a few bones in fragments.

This mound, 2.5 feet high and 50 feet across the base, was totally dug down by us.

Seven burials were met with, the first 11 feet in from the NE. margin of the mound, on the base as were all with one exception. The remaining burials continued in at intervals until the center of the mound was reached.

Burial No. 1.—Part of a pelvis covered by a *Fulgur perversum* having the mortuary perforation. Presumably other bones of the deposit, not thus protected, had disappeared.

Burial No. 2.—Small decaying fragments of a femur and of a tibia, side by side.

Burial No. 3.—In a shallow grave below the base of the mound were fragments of a skull and bits of two femurs.

Burial No. 4.—A small fragment of decaying bone.

Burial No. 5.—Bits of two femurs and of one tibia.

Burial No. 6.—The remains of a skull.

Burial No. 7.—Decaying fragments of a cranium.

We believe that other burials had disappeared from the mound through decay, but think such were from the neighborhood of those we have described, as no discolored earth or sign of interment of any sort was found in other portions of the mound.

Exactly in the same line with the burials, but beginning at the margin, in blackened sand, were many sherds, and fourteen vessels, three or four together at times, some whole, some crushed to pieces.

Vessel No. 1.—An imperforate bowl of about 1 quart capacity, of inferior yellow ware, having an almost uniform incised and punctate decoration around the upper part (Fig. 60). This vessel, unlike all others in the mound, had no basal perforation.

Fig. 60.—Vessel No. 1. Holley mound. (Half size.)

Vessel No. 2.—A compartment vessel with four divisions on one plane and a fifth in the center, somewhat above the rest (Fig. 61). The central compartment has a basal perforation which does not show in the half-tone. Length, 8.7 inches; width, 7.1 inches; height, 2.3 inches.

Vessel No. 3.—A pot of about 1 quart capacity, undecorated, almost cylindrical, expanding slightly toward the base which is flat.

Fig. 61.—Vessel No. 2. Holley mound. (About three-fourths size.)

FIG. 62.—Vessel No. 8. Holley mound. (Half size.)

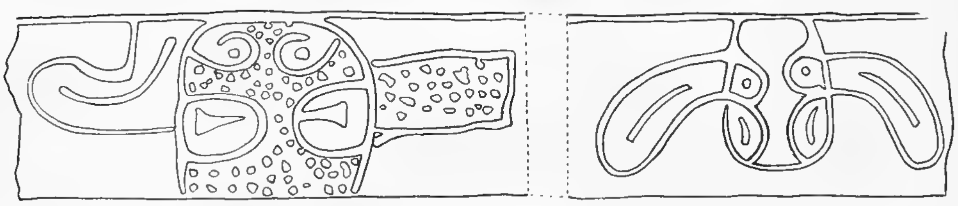


FIG. 63.—Vessel No. 8. Decoration. Holley mound. (Half size.)

FIG. 64.—Vessel No. 12. Holley mound. (Half size.)

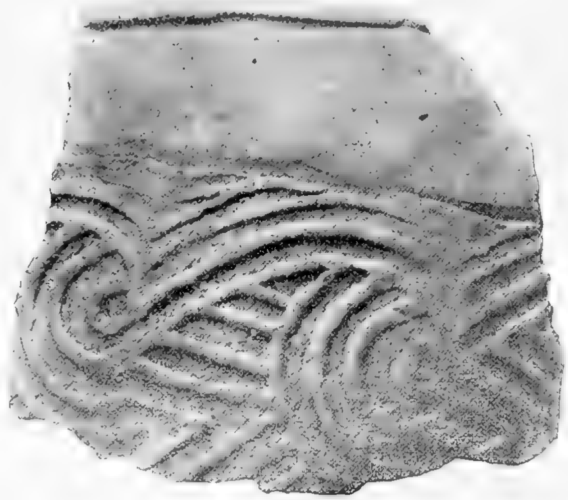


FIG. 65.—Sherd. Holley mound. (Three-fourths size.)

Vessel No. 4.—Globular, about 3 quarts capacity, thickening at the rim. The decoration is a faint complicated stamp.

FIG. 66.—Sherd. Holley mound. (Half size.)

Vessel No. 8.—Quadrilateral, of yellow ware, broken into many fragments when found. The rim, which turns inward nearly at right angles, has incised decoration. There are incised and punctate designs on three sides, that on the fourth having been worn away. The bowl with the decoration on one side is shown in Fig. 62, while the designs on two other sides are given diagrammatically in Fig. 63.

Vessel No. 12.—A vase made to hold about 3 quarts, with hemispherical body and neck at first constricted, then flaring, around which is a complicated stamp decoration (Fig. 64). With this vessel were sheets of mica.

The complicated stamp designs on two sherds are shown in Figs. 65, 66.

SOWELL MOUND, WASHINGTON COUNTY.

This mound, on property of Mr. Jesse Sowell of West Bay P. O., Florida, is in scrub about 1 mile in a westerly direction from Bear Point. Previous to our visit a trench 12 feet across had been dug from the northern margin of the mound almost to the center. The height of the mound was 4.5 feet; the basal diameter, 50 feet. A great depression whence the sand for the mound had been taken was at its southern margin. All parts of the mound, not before dug, were carefully gone through by us, beginning at the extreme outer limit.

On the extreme eastern margin burials were encountered consisting of flexed skeletons, bunched burials, scattered bones and masses of bones, one of these masses having no less than six skulls. These burials extended without intermission until the center of the mound was reached.

At first the attempt was made to keep count of the burials, but the difficulty to determine where one ended and another began forced us to limit ourselves to a tally of skulls only, and of these there were one hundred and twenty-one.

All burials but three were confined to the eastern part of the mound between the margin and the center, and were, to a certain extent, superficial, lying between a few inches and 2 feet from the surface. Three burials came from the western part of the mound, one 19 feet from the margin, the other two a few feet farther in. Two of these burials were on the base. One was about 2.5 feet from the surface.

The bones in this mound were in a far better state of preservation than are

those usually found by us, and, in consequence, a number of crania, now belonging to the Academy of Natural Sciences, were saved.

Many of these skulls showed great antero-posterior flattening as by compression from boards, while some gave evidence of early constriction by a band, a concave depression being evident. A selected skull from this mound is shown in Fig. 67. Captain Bernard Romans, who was familiar with this part of Florida, writing in the

FIG. 67.—Skull showing artificial flattening. Sowell mound. (Two-thirds size.)

latter part of the XVIII century, tells[1] us that in his time the Choctaws bound bags of sand to the heads of male children. In this mound, however, all skulls which were in a condition to allow determination, showed flattening.

All skeletons but one which lay on the back with the legs drawn up under the thighs, were closely flexed, some lying on the right side, some on the left. With certain burials were a small number of oyster shells.

[1] "Concise Natural History of East and West Florida."

With the skeleton of a child were many small shells (*Marginella apicina*),[1] perforated for use as beads.

A pendant of igneous rock was found unassociated with human remains and a smoking pipe of steatite lay in sand thrown out by previous diggers.

Beginning with the burials and continuing with them until the end, were great numbers of sherds, parts of vessels and vessels unbroken or crushed but with full complement of parts. This deposit of earthenware, which included 53 vessels entire or, when broken, with all but small parts present, began at the margin with great numbers of sherds, undecorated or having the check stamp as a rule. Next came a few scattered vessels and, shortly after, the first burials were found. Thence on, earthenware and burials continued more or less closely associated, a burial at times being almost in direct contact with two or three vessels.

All earthenware in this mound, as far as noted, had the usual base-perforation, as did a shell drinking cup associated with the pottery, and lay in sand blackened with organic matter.

Though much of the ware in this mound was broken, perhaps through close contact, vessels sometimes being one within another, and once even a vessel, contained in another, itself held a third, yet a considerable amount was recovered intact, or nearly so. Unfortunately, the decoration, mainly incised and punctate, only four vessels having the complicated stamp, does not average as high from an artistic point of view as does that from certain other mounds in this district.

FIG. 68.—Vessel No. 1. Sowell mound. (Full size.)

We shall now describe the more notable vessels from this mound.

Vessel No. 1.—Almost an inverted truncated cone in shape with punctate decoration shown in Fig. 68. There are holes on opposite sides for suspension. Height, 3.1 inches; maximum diameter, 2 inches.

Vessel No. 3.—Of ordinary form with two encircling bands, the upper formed of three rows of upright linear impressions; the other, a little less than 1 inch below, of two rows of larger impressions of the same style.

Vessel No. 5.—A pot of about 1 pint capacity, covered with rows of small circular impressions, probably made with the end of a reed.

Vessel No. 14.—Oblate spheroid with incised and punctate decoration as shown in Fig. 69. Height, 4.3 inches; maximum diameter, 10.5 inches.

Vessel No. 18.—Ovoid, has for decoration three encircling rows of punctate linear impressions. In addition to the basal perforation, two others have been made on the side.

[1] All shells referred to in this report have been determined by Dr. H. A. Pilsbry, of the Academy of Natural Sciences.

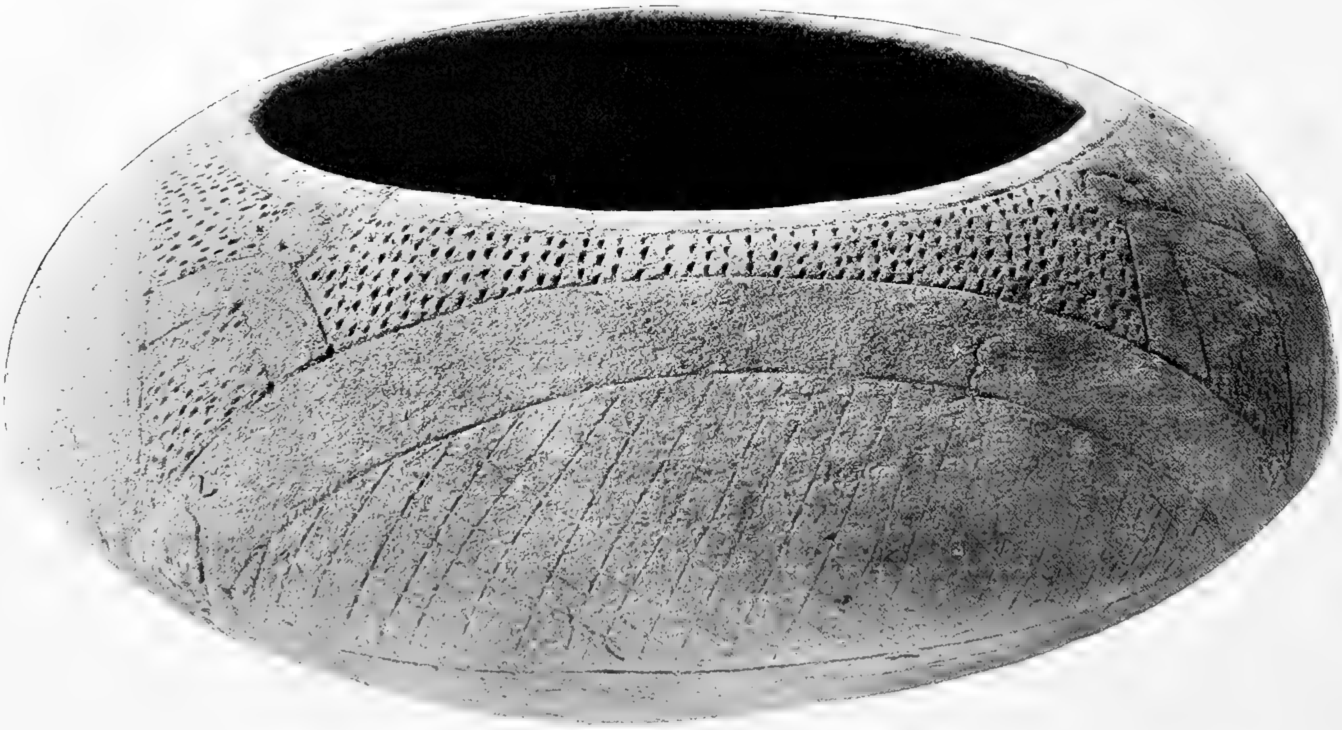


FIG. 69.—Vessel No. 14. Sowell mound. (Two-thirds size.)

Vessel No. 19.—A jar of about 1 quart capacity, undecorated but of somewhat unusual form. Part of the neck is missing. There are two perforations, which may have been for suspension.

Vessel No. 23.—An undecorated vessel holding about 1 pint, in shape resembling two much-flattened spheres, one upon the other. There have been two perforations for suspension, one of which is now included in a broken portion.

Vessel No. 25.—A pot of inferior ware of about 6 quarts capacity, having around the upper part of the body a series of roughly incised designs, all similar, consisting of diagonal parallel lines between parallel upright ones (Fig. 70).

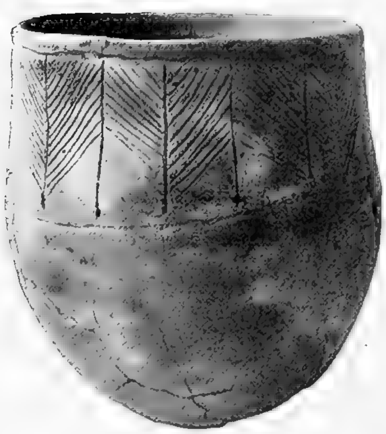


FIG. 70.—Vessel No. 25. Sowell mound. (One-quarter size.)

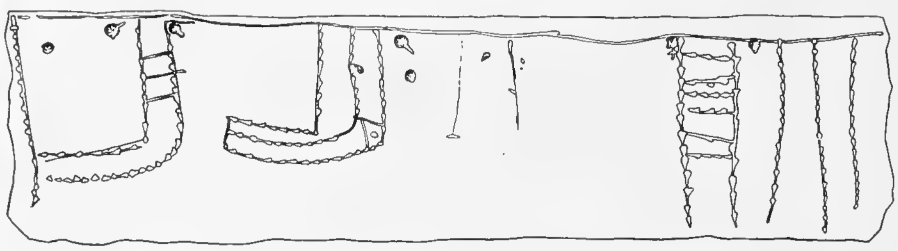


FIG. 71.—Vessel No. 28. Decoration. Sowell mound. (One-third size.)

Vessel No. 28.—A pot of about 1 quart capacity, with rude decoration shown diagrammatically in Fig. 71.

Vessel No. 29.—A pot rather rudely decorated with incised horizontal and diagonal lines, which enclose similar designs on two opposite sides of the vessel (Fig. 72).

Fig. 72.—Vessel No. 29. Sowell mound. (Half size.)

Vessel No. 31.—A three-lobed vessel holding about 1 quart, with three rudimentary bird-heads on the rim at the junction of the lobes (Fig. 63). The decoration, incised, extending over the sides and bottom of the vessel, is shown diagrammatically in Fig. 74.

Vessel No. 32.—Has for decoration a series of parallel diagonal lines at angles to each other, rudely executed.

Vessel No. 33.—Of about 2 quarts capacity, had a piece missing, the result of aboriginal breakage, as a perforation for repair is near the margin of the fracture. The missing portion has since been restored by us (Fig. 75). The incised design is repeated around the vessel.

Fig. 73.—Vessel No. 31. Sowell mound. (Full size.)

Vessel No. 36.—Of about one-half pint capacity, tapering sharply to the base and somewhat toward the aperture. There is a faint decoration of incised curved lines (Fig. 76).

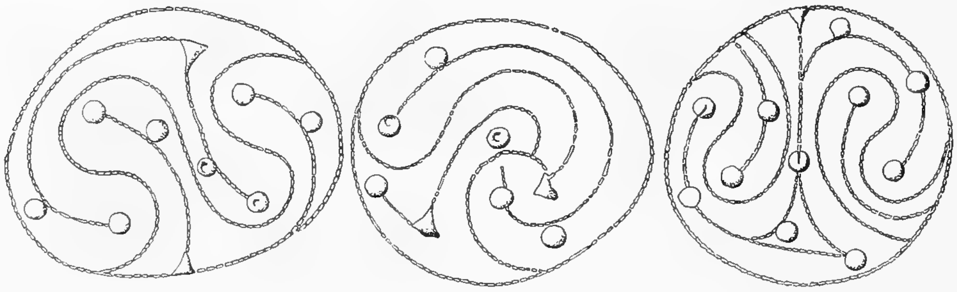


FIG. 74.—Vessel No. 31. Decoration. Sowell mound. (One-third size.)

Vessel No. 41.—A small triangular bowl, undecorated and of inferior ware.

Vessel No. 43.—A vessel of oval section longitudinally, of about 3 pints capacity, covered with crimson pigment inside and out, having at one end a fantastic representation of the head of a bird and, at the other, the conventional tail (Fig. 77).

FIG. 75.—Vessel No. 33. Sowell mound. (Seven-eighths size.)

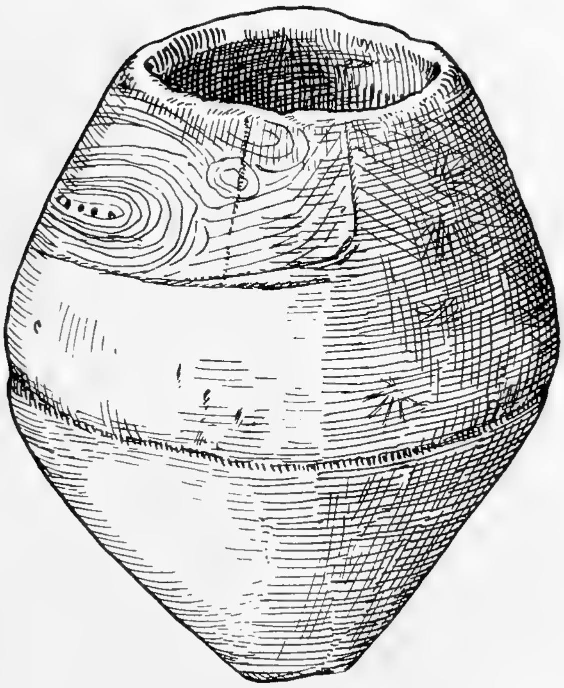


FIG. 76.--Vessel No. 36. Sowell mound. (Full size.)

FIG. 77.--Vessel No. 43. Sowell mound. (Half size.)

FIG. 78.--Vessel No. 46. Sowell mound. (Half size.)

FIG. 79.--Sherd. Sowell mound. (Four-fifths size.)

Vessel No. 44.—An undecorated vessel of inferior ware, holding about 1 pint, with globular body and upright quadrilateral neck.

Vessel No. 46.—Rather heart-shaped in outline of body, with neck slightly expanding and surrounded by incised parallel lines. From the rim extend four equidistant horizontal projections. The ware is inferior (Fig. 78). Height, 7 inches; diameter of body, 6.6 inches.

Vessel No. 49.—A flattened sphere with upright rim, with decoration much similar to that on Vessel No. 14 from this mound.

A sherd with complicated stamp decoration is shown in Fig. 79.

In the pottery deposit were several parts of a vessel of better quality of ware and more artistic decoration than characterized any other earthenware from this mound. On one fragment is the head of a duck, not projecting from the rim but in relief on the side.

Mounds near Bear Point, Washington County.

In thick hammock, about 100 yards from the water and one-quarter of a mile from Bear Point, approximately, on property of Lieutenant-Commander Francis H. Sheppard, U. S. N., retired, of St. Andrews, Fla., was a mound which had undergone but little digging previous to our visit. Its basal diameter N. and S. was 60 feet and 50 feet E. and W. Its position on a slope made its height somewhat deceptive. On one side the altitude was but 20 inches. On the opposite side, the east, its height was about 4 feet. It was completely dug down by us.

The first burial was found in the NE. part of the mound, 7 feet in from the margin. Other burials were met with in the same direction, continuing in or a little to the eastward or to the NNE. Near the center one burial to the N. was noted. One lay in the center. These burials, twelve in all, had occasionally a few oyster shells in the sand above them. Three skeletons were closely flexed on the right side and one on the left. One skeleton occupied a squatting position. There were three bunched burials and scattered bones were found in three places. A few decaying fragments were all that remained of one burial.

All bones were badly decayed. No skulls were saved, though fragments were met with sufficiently large to show that cranial compression had been practised.

A "celt" of volcanic rock lay with a burial. Another, about 4 feet distant from human remains, also of volcanic rock, 9 inches long and two inches across the cutting edge, tapered gracefully to a blunt point .5 inch in diameter at the other end.

A ball of lead sulphide was found unassociated.

A number of sherds, undecorated, with the check stamp or with the complicated stamp, were in the NE. margin of the mound and continued into the mound, lying here and there. Near the center of the mound was an undecorated vessel in fragments and at the center was a small undecorated vessel, resembling the longitudinal section of a gourd. Part of the handle, which was solid, is missing. There is a basal perforation.

Near this mound, to the westward, is a considerable shell deposit composed of irregular ridges having a maximum height of 7 feet. There is also a circular enclosure of shell. These deposits are said to be the largest of the kind until the great shell-heaps begin a few miles to the north of Cedar Keys, and this was confirmed by our observations later.

Still farther westward are three flat mounds, which careful digging indicated to belong to the domiciliary class.

Cemetery at St. Andrews, Washington County.

For a considerable time citizens of St. Andrews and visitors to that town have admired a collection of aboriginal earthenware in the possession of Mr. Isaac Godard, living at that place. Mr. Godard informed us that while digging in an enclosure adjoining his home, he had come upon vessels of earthenware and, with the aid of a rod, he had located and secured about twenty of them.

Fig. 80.—Vessel of earthenware. Cemetery at St. Andrews. (About two-thirds size.)

According to Mr. Godard, certain smaller ones among these vessels lay with burials, while others, bowls, were over skulls. In two cases human remains lay in bowls each covered by an inverted vessel.

With Mr. Godard's permission, the field, a small one, surrounded by an irregular, circular shell ridge, 2 feet to 4 feet high and about 170 feet in diameter, was carefully sounded by us. Mr. Godard's search, however, had been a thorough one and only a single vessel rewarded our investigation. This one, a bowl, lay base

uppermost about 3 feet from the surface. No bones were found beneath it, but it is our confident belief that infant remains, placed there originally, had disappeared through decay.

The bowl, of a type very familiar to us during our investigations of the preceding year, is dark in color with incised decoration representing, probably, a highly conventionalized animal head with a circle presumably intended for an eye. This design occurs six times. In addition, there are two pairs of curved figures, possibly representing legs, while two sets of animal jaws and teeth, in combination, appear but once (Fig. 80). This last is a new feature to us, though single sets of jaws on bowls in the district to the westward are common enough. Maximum diameter, 11 inches; height, 5.5 inches.

This discovery of a cemetery is of some interest, establishing, as it does, the existence of urn-burials at a point farther to the eastward than had been noted before.

Mound at St. Andrews, Washington County.

This mound, in the western limits of the town, on property of Mr. J. A. Moates, living nearby, literally has been dug to pieces. After a short trial, investigation was abandoned by us. The mound seems to have been elliptical in outline originally, about 110 feet along the base NE. and SW. and 58 feet NW. and SE. The height, probably, was about 7 feet.

Mound near Davis Point, Calhoun County.

This mound, much dug into before our visit, lay in hammock land on property of Mr. Hawk Massaliner, colored, who lives on the place. Its height was about 2 feet 9 inches; the basal diameter, 45 feet. It was completely dug down by us.

On the extreme eastern margin were burials and numbers of parts of different vessels, mostly undecorated, some bearing the check-stamp. The burials and earthenware continued in to the center of the mound, the area of deposit broadening somewhat to the SE.

As the digging continued burials became more numerous for a while, and several were found included between the limits NE. and W. by S., though the deposit of earthenware which farther in included whole vessels and broken vessels of which all parts were present, and many sherds, was not present with burials in that part of the mound.

One small vessel, however, lay SW. of the center.

The mound was largely composed of sand blackened by admixture of organic matter, thus excavations made and filled previous to our visit were hard to locate, the sand being of the same color, therefore data, burial by burial, were not collected. The closely flexed form, the bunch, scattered bones and masses of bones were found in abundance. No skulls were recovered entire, but large fragments showed flattening of the frontal and occipital portions.

One burial, a bunch, lying under oyster-shells, as was often the case with inter-

ments in this mound, had a left femur which had sustained fracture at an early period and had united with little inconvenience to the subject, an occurrence somewhat out of the usual run in aboriginal times, judging from other fractures found by us in mounds. This femur was sent to the United States Army Medical Museum, Washington, D. C.

With one or two burials in the mound were parts of human bones, some discolored by fire, some charred and one or two calcined, but this evidence of the use of fire in no case extended to the entire burial, nor even to a considerable part of it, making it evident that cremation had not been practised, but rather the use of fire, ceremonially, which had occasionally burned a small portion of the bones.

Of artifacts in the mound there were, exclusive of earthenware, a mass of rock about twice the size of a closed hand, having on one side a pit 2.5 inches in depth and about 1.5 inches in diameter, and on the other side three small pits and a concave area produced by wear; a mass of lead sulphide, pitted on one side, evidently by use as a hammer; two graceful celts, one found with a burial, the other in caved sand; thirty-seven pointed columellæ of large marine univalves, found with a burial.

There were also in caved sand a small fragment of sheet copper badly carbonated, and a piece of sheet copper about 7 inches square, broken on three sides, which had formed part of a square or oblong ornament with a central perforation surrounded by punctate markings. The margin of the sheet had been carefully turned over and hammered down. On the metal were traces of a vegetable fabric in which the bones, which the copper accompanied, had been wrapped.

The copper, analyzed by Prof. Harry F. Keller, Ph.D., contained small quantities of iron and a faint trace of silver. Lead, arsenic, antimony, bismuth, nickel, etc., were entirely absent. This copper, then, is native copper, of a purity above that of any copper made from the sulphide ores found in Europe, especially in former times.

Incidentally we may say it is now eight years since we made public in the second part of our "Certain Sand Mounds of the St. Johns River, Florida," results of many careful analyses of native copper and of copper from the mounds, and showed chemically that most of the copper of the mounds could not have been produced in Europe, but was native copper, hammered out from nuggets or masses by the aborigines. These conclusions were accepted, we believe, by all who do not prefer an unsupported opinion to weight of evidence. At all events, no effort has been made, based on analyses, to controvert our deductions.

The Davis Point mound was filled with roots of the palmetto, doubly destructive to earthenware in that, while tearing it apart themselves, they compel from the investigator heavy blows of axe and spade, fatal to neighboring earthenware. This fact and the aboriginal custom to break vessels and scatter their parts throughout the mound, which markedly had prevailed in this mound, made it so that but three vessels were taken out unbroken, even as to parts unaffected by basal perforation. This is especially to be regretted as the ware of this mound, if we exclude the check-

stamp on certain coarse sherds, was of the incised and punctate variety which demands more originality and artistic ability than does the complicated stamp so prevalent in the mounds of this district.

Vessel No. 1.—This vessel, of excellent yellow ware, shown in Fig. 81, lay with a mass of bones. On the upper portion punctate markings constitute a field on which two rattlesnakes with highly conventionalized heads appear in relief. In this connection it is interesting to compare the rattlesnake decoration on the two vessels from the Hall mound, described and figured later, where heads much

FIG. 81.—Vessel No. 1. Mound near Davis Point. (About six-sevenths size.)

less conventionalized are given. Between the rattlesnakes, on either side, is an incised figure somewhat resembling a flying bird, shown in diagram (Fig. 82). The wings, if such they are, of one point downward; one wing of the other is raised. On examining the vessel, however, one can see the outline, faintly incised, of a lowered wing, which could not be completed owing to lack of space and, therefore, a raised wing was substituted. Beneath one rattlesnake is a rude cross shown in the half-tone. There are handles projecting obliquely from the rim, connecting with the heads of the snakes. Maximum diameter, 7 inches; height, 5.5 inches.

Vessel No. 4.—A small cup shown in Fig. 83.

Vessel No. 7.—A rude life-form of about 1 quart capacity (Fig. 84).

Vessel No. 8.—A vessel of about 1 quart capacity with rounded body and neck first constricted, then flaring. The decoration consists of incised perpendicular lines, probably intended to be parallel (Fig. 85).

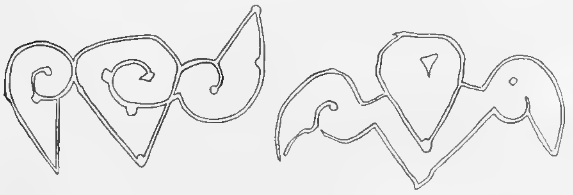


FIG. 82.—Vessel No. 1. Decoration. Mound near Davis Point. (Half size.)

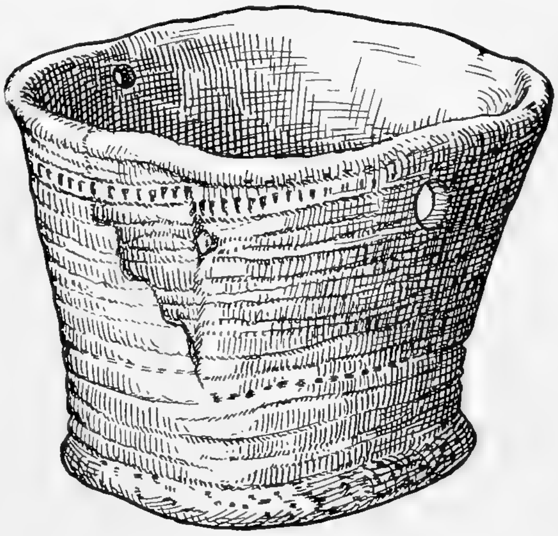


FIG. 83.—Vessel No. 4. Mound near Davis Point. (Full size.)

Vessel No. 11.—Part of a vessel with interesting incised decoration shown in Fig. 86.

Vessel No. 12.—A jar of excellent red ware with a body of heart-shaped section and a neck first constricted, then expanding. There are two similar groups of incised decoration on the neck. A part of the rim has been restored (Fig. 87). Height, 8.5 inches; maximum diameter, 6.2 inches.

Vessel No. 14.—The lower half of a small effigy-vessel (Fig. 88), which has represented a human figure wearing a breach-clout adorned with ornaments on the side and back. Careful, but unsuccessful, search was made for the missing portion of the figure.

FIG. 84.—Vessel No. 7. Mound near Davis Point. (Half size.)

FIG. 85.—Vessel No. 8. Mound near Davis Point. (Half size.)

Vessel No. 17.—This vessel, globular in shape, with oval aperture (Fig. 89) has a capacity of about one quart. The decoration, incised, representing wings and tail,

FIG. 86.—Vessel No. 11. Mound near Davis Point. (Twelve-thirteenths size.)

FIG. 87.—Vessel No. 12. Mound near Davis Point. (Half size.)

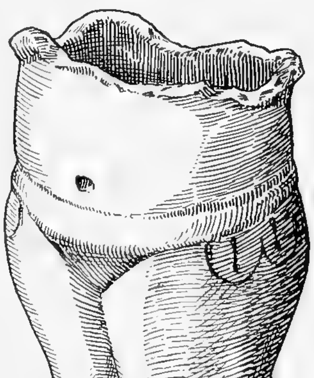


FIG. 88.—Vessel No. 14. Mound near Davis Point. (Two-thirds size.)

includes a design on the breast (Diagram, Fig. 90). The head of a bird projects from one side.

Vessel No. 18.—A jar with faint check-stamp ornamentation (Fig. 91). Height, 11 inches; maximum diameter, 4.8 inches.

Vessel No. 19.—This vessel, of unusual shape, found crushed to bits and with portions missing, has been cemented together with restoration. The decoration is coarsely done (Fig. 92).

FIG. 89.—Vessel No. 17. Mound near Davis Point. (About full size.)

Vessel No. 20.—A bowl of about 2 quarts capacity, found broken into many pieces, some of which were not present with the rest. The decoration, which is on the upper part, consists of a zigzag and a meander, in places, running through a field alternately cross-hatch and punctate.

In Fig. 93 is shown a bird-head handle which, when found, contained nine flat bits of earthenware constituting a rattle within the head. Rattling vessels of this sort are rare along the northwest Florida coast, one having been found by us last year and three during the present season.

In Fig. 94 is shown a sherd of most excellent ware with bird-head handle and incised representation of a wing.

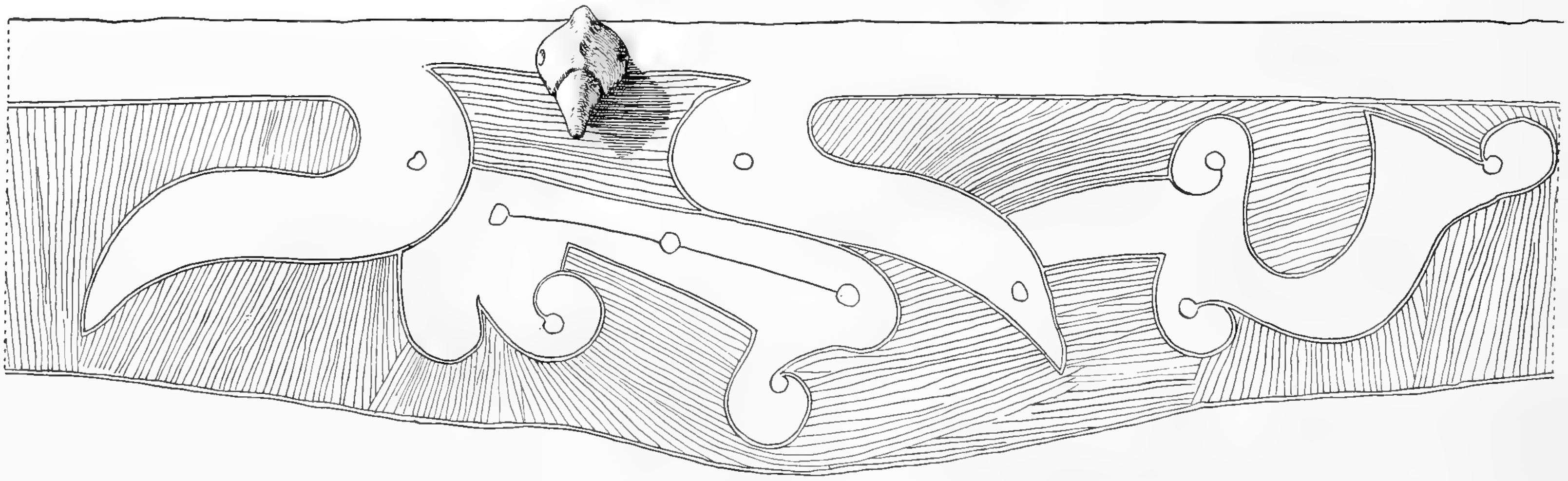


FIG. 90.—Vessel No. 17. Decoration. Mound near Davis Point. (Half size.)

FIG. 91.—Vessel No. 18. Mound near Davis Point. (One-fifth size.)

FIG. 92.—Vessel No. 19. Mound near Davis Point. (Full size.)

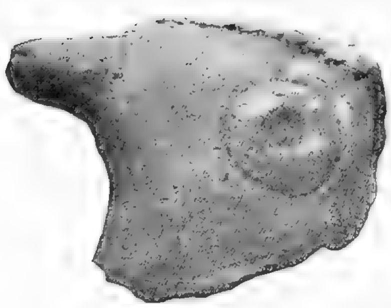


FIG. 93.—Handle of vessel. Mound near Davis Point. (Three-fourths size.)

FIG. 94.—Sherd. Mound near Davis Point. (Half size.)

MOUND NEAR PEARL BAYOU, CALHOUN COUNTY.

Pearl bayou joins East bay, a part of St. Andrew's bay, on the south side about 5 miles from the entrance to East bay. The mound, as to whose ownership we are in ignorance, is within sight of the water in a field formerly cultivated, but now overgrown, about 1 mile in an easterly direction from Pearl bayou.

The mound formed no exception to those of this district, having been dug into in many places. It was 40 feet across the base and about 3.5 feet in height. It was completely dug through by us with the exception of a part of the western portion, where digging was discontinued after a large percentage had been gone through without finding burial or artifact.

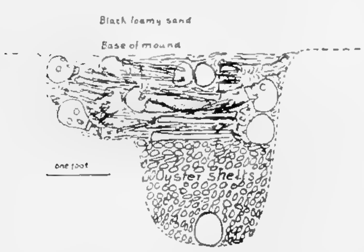


FIG. 95.—Section of grave. Mound near Pearl Bayou.

Burials and numerous sherds were encountered in the eastern margin. The burials which, later, extended in a scattering way to the SE. and one even so far as N., continued to be met with in great numbers in the eastern part of the mound until the center was reached, after which none was found. The marginal burials were closely flexed on the right side or on the left, but later such a mass of bones was present that the form of burial was hard to determine. Presumably, the burials were of the flexed variety, overlapping and underlying each other in greatest confusion. No skull was saved, though some were sufficiently entire to allow determination as to cranial compression. This compression, plainly distinguishable in some, was much less so in others, while certain ones showed no trace of it.

FIG. 96.—Lancehead of chert. Mound near Pearl Bayou. (Full size.)

In the outer portion of the mound, especially, though their presence was noted among the burials farther in, were many small shallow graves into which the burials had been forced. A number of interments were covered with oyster-shells. Under a mass of burials with which were numbers of shell drinking cups, some perforated as to the base and some not, was a grave containing a single skeleton, running below the base, filled with oyster-shells (Fig. 95).

A feature in this mound was the number of shell drinking cups present, numbers being found together at times.

Usually closely associated with burials were eight celts, gracefully shaped as a rule and tapering to a blunt point opposite the cutting edge, the longest having a length of 10.2 inches. One had an edge so blunt, though smooth and rounded, that it would seem to have been made for a purpose other than to cut.

There were also in the mound: a barbed arrowhead of chert, found with a burial; mica in several places; a large hammer-stone.

In caved sand was a beautifully wrought barbed lance-head of chert, 5.6 inches in length and .25 of an inch in maximum thickness (Fig. 96).

After the marginal sherds, a few feet farther in, associated with a great mass of bones, continuing to the center of the mound from the eastern part, at times extending to the NE. on one side, to ESE. on the other, were numbers of vessels and parts of vessels and deposits of sherds mixed together. Many of the fragments,

FIG. 97.—Sherd. Mound near Pearl Bayou. (Four-fifths size.)

FIG. 98.—Sherd. Mound near Pearl Bayou. (One-third size.)

no doubt, belonged to vessels intentionally broken and scattered through the mound by the aborigines at its building.

Thirty-three vessels were noted by us as found entire or having nearly a full complement of fragments. As a rule the ware was inferior and little care seemed to have been taken with the decoration. The check-stamp was present on a few vessels and on many sherds. The complicated stamp was sparingly represented. Two specimens are shown in Figs. 97, 98.

We shall now take in detail the most noteworthy vessels, all of which but three had the basal perforation.

Vessel No. 2.—A pot with a small check-stamp as decoration. The ware is extraordinarily thick and heavy.

Fig. 99.—Vessel No. 10. Mound near Pearl Bayou. (Full size.)

Vessel No. 6.—A small cup or bowl with four rudimentary feet. A line of punctate markings surrounds the rim. On opposite sides are perforations for suspension.

Vessel No. 10.—A most artistically shaped vessel of superior ware, of about 2 quarts capacity. The body is almost trilobate, the upright neck is nearly circular with undulating margin. The base is flat. The decoration, carefully done, consists of a series of incised lines (Fig. 99).

Fig. 100.—Vessel No. 11. Mound near Pearl Bayou. (Half size.)

Fig. 101.—Vessel No. 13. Mound near Pearl Bayou. (Half size.)

Vessel No. 11.—A cup almost cylindrical, flaring slightly. At four equidistant points on the rim have been small protuberances, probably rudimentary bird-heads, of which three yet remain. The decoration, which is uniform all around, consists of various designs made of combinations of the symbol of the bird (Fig. 100).

Vessel No. 13.—A bowl without basal perforation, an elongated oval in longitudinal section. A line of punctate impressions is below the margin, also a rather rude incised decoration on either side and the length of the base. There is but one hole for suspension (Fig. 101).

Fig. 102.—Vessel No. 15. Decoration. Mound near Pearl Bayou. (One-third size.)

Fig. 103.—Vessel No. 23. Mound near Pearl Bayou. (Half size.)

Vessel No. 15.—Is of about 2 quarts capacity and semi-globular as to the lower

part. The upper portion, on which is incised decoration, shown in diagram in Fig. 102, turns inward.

Vessel No. 23.—Roughly heart-shaped with flattened base (Fig. 103). The aperture is elliptical. Two and one-half inches apart, on the same side, are perforations for suspension, a method of placing these holes new to us when this vessel was found, but met with by us a number of times afterward, along the coast. The decoration consists of crimson paint at either end of the vessel, on the outside.

Fig. 104.—Vessel No. 28. Mound near Pearl Bayou. (Eight-ninths size.)

Between, at first glance, seems to be an undecorated space, though, on closer inspection, traces of pigment are apparent, and might indicate that a band had surrounded the vessel, friction against which had worn away the paint.

Vessel No. 27.—A bowl of red ware found in many pieces. The decoration consists of two incised curved lines on one side and on the other, two designs roughly made composed of four concentric circular lines around a number of punctate markings.

Vessel No. 28.—A vessel found in fragments and since put together with slight restoration is a life-form representing a duck with head in relief, *repoussé* wings and tail on which is incised and punctate decoration including the symbol of the bird (Fig. 104).

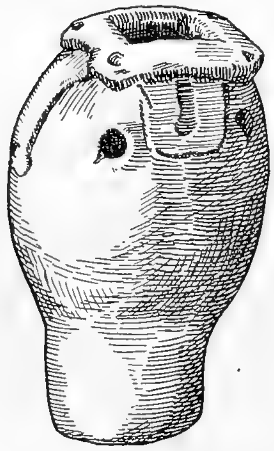


FIG. 105.—Vessel No. 29. Mound near Pearl Bayou. (Two-thirds size.)

Vessel No. 29.—A rudely made quadrilateral vessel with imperforate base and two holes for suspension beneath the rim on the same side. The decoration consists of circular punctate markings at each corner of the almost square aperture and designs in relief on the four sides below the rim (Fig. 105).

FIG. 106.—Vessel No. 33. Mound near Pearl Bayou. (Half size.)

Vessel No. 33.—An undecorated quadrilateral vessel with flat base and a projection at each corner. There are perforations for suspension on opposite sides (Fig. 106).

One bowl, broken when found, held a pot in which was a still smaller one lying on its side.

MOUNDS NEAR LAUGHTON'S BAYOU, WASHINGTON COUNTY. MOUND A.

Laughton's bayou unites with East bay on the north side about seven miles up. The mound was about one-half mile in a southerly direction from the head of the bayou, in a field, the property of Messrs. P. F. and C. T. Parker, of Parker P. O., Florida.

The mound, which had sustained a considerable amount of previous digging, was, before its complete demolition by us, 3.5 feet in height and 45 feet across the base.

In the same field were considerable shell deposits much spread by the plough, including a circular shell enclosure.

As we had anticipated, sherds and large parts of vessels were encountered at the very margin of the eastern slope of the mound. The deposit continued in 4 or 5 feet, accompanied here and there by complete vessels or some from which small parts only had been broken, and by a number of pots and bowls or considerable parts of them, very badly crushed. No other earthenware was met with in the mound.

Of the nine vessels recovered in fair condition, three only call for description.

Vessel No. 2.—A quadrilateral bottle with flat base and upright neck, around which is decoration in relief (Fig. 107).

Vessel No. 3.—Has a globular body somewhat elongated toward the base, which is flat. The upper part is surrounded by a complicated stamp rudely impressed.

Vessel No. 6.—A small bowl of inferior ware decorated with a sort of meander made up of a number of almost parallel lines rudely incised. In this mound was no check-stamp decoration, though the complicated stamp, one example of which is shown in Fig. 108, was abundantly found. All vessels were of inferior ware and decoration, and all had the basal perforation. Near certain vessels lay sheets of mica.

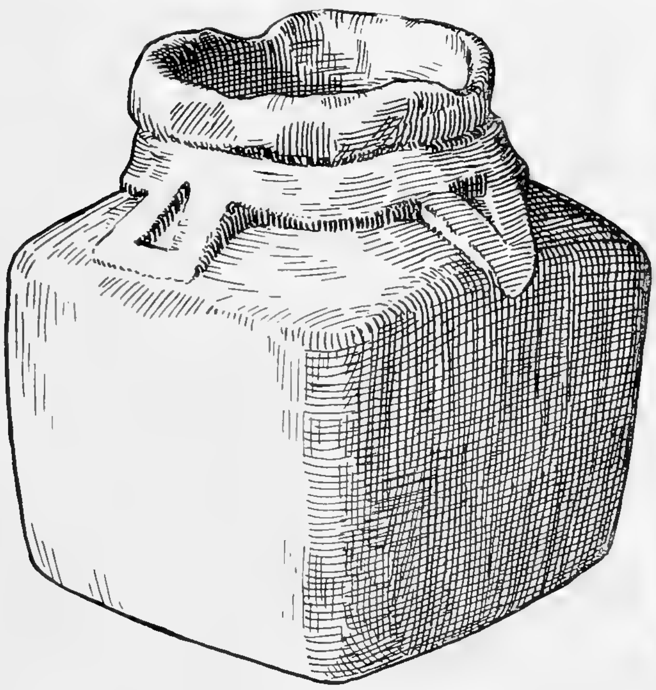


FIG. 107.—Vessel No. 2. Mound A, Laughton's Bayou. (Full size.)

FIG. 108.—Sherd. Mound A, Laughton's Bayou. (Three-fourths size.)

No human remains were met with until within a few feet from the center when burials were encountered once to the N. and six times to the NE. and E., all badly decayed, at times traces alone remaining in the sand. Two skulls lay together; one lay alone. One skull had traces of bones in association.

MOUNDS NEAR LAUGHTON'S BAYOU, WASHINGTON COUNTY. MOUND B.

This mound, in hammock land, on the eastern side of the creek which enters the bayou at its head (mound A was on the W. side) was about one-half mile in a SW. direction from the head of the bayou, also on property of the Messrs. Parker. A trench about 5 feet broad had been carried in from the western margin to the center of the mound, previous to our visit. The mound, which was 7 feet high and 43 feet in basal diameter, was entirely dug through by us with the exception of the former trench and a small part of the mound bordering it.

The inevitable deposit of sherds and broken vessels was encountered at the extreme verge of the eastern slope, but in less numbers than was usually the case. The full complement of fragments of not over ten or twelve vessels were found, but none was recovered entire. These vessels, which were of inferior ware and decora-

tion, continued on toward the center of the mound, never immediately with burials, but sometimes in their vicinity, perhaps two or three feet away.

FIG. 109.—Vessel No. 1. Mound B, Laughton's Bayou. (Six-sevenths size.)

A number of fragments of vessels had the basal perforation made before baking.

But two vessels worth detailed description were taken by us from this mound.

Vessel No. 1.—This vessel, of eccentric form, elliptical in cross section, bears traces of crimson pigment inside and out; on one side is raised decoration, on the other, the same pattern is shown but with deeply incised lines. Two holes are on the same side of the vessel for use for suspension or attachment (Fig. 109). Perforations thus placed, the reader will recall, were found by us in a vessel in the mound at Pearl bayou. From this time on we were destined to meet a number of them.

Vessel No. 2.—A fine example of the "freak," or ceremonial, ready-made, mortuary ware, having not only a perforation made in the base before baking, but holes throughout the body of the vessel. The vessel represents a horned owl with feather markings around the head, *repoussé* wings and the conventional tail (Fig. 110). One horn, missing from the vessel, has been restored. Height, 10.3 inches; maximum diameter, 7.3 inches.

Part of a vessel with a rude bird-head projecting from the end has a number of circular holes at either side of the neck (Fig. 111).

Burials, nine in number, were confined to the E., SE. and ENE. parts of the mound, beginning near the margin and continuing in to the center. Some were badly decayed, rendering impossible a determination as to the form of burial. The closely flexed burial and the bunched were present in the mound in several instances. In some cases oyster-shells lay over burials in the mound and once over a shallow grave beneath the base.

With two burials were gracefully shaped "celts", near one of which lay also a number of shells (*Marginella apicina*), pierced for use as beads.

The ceremonial use of fire was clearly emphasized in this mound. Near one burial lay a mass of charcoal and the sand was discolored by heat, though the bones showed no trace of it. The central portion of the mound, extending several feet in

FIG. 110.—Vessel No. 2. Mound B, Laughton's Bayou. (About six-sevenths size.)

all directions, seemed to be discolored by fire, though charcoal in masses was not present, and made into a sort of cement through admixture of ashes. The material was so tough that a pick rather than a shovel was needed.

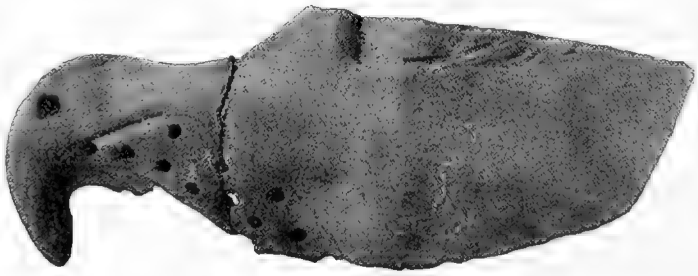


FIG. 111.—Sherd. Mound B, Laughton's Bayou. (About half size.)

No trace of human remains was present in other parts of the mound. We are constrained to believe that cemeteries exist around St. Andrew's bay, whose position we have been unable to locate.

MOUND NEAR STRANGE'S LANDING, CALHOUN COUNTY.

This mound, in hammock land, about one-half mile in a westerly direction from the landing, on East bay, is on property belonging to Mr. William Strange, living nearby.

The mound, which was about 4 feet high and 38 feet across the base, was the

FIG. 112.—Vessel No. 1. Mound near Strange's Landing. (About full size.)

usual truncated cone in shape and had been very symmetrical until persons previous to our visit dug a trench 22 feet long and 6 feet broad from the western margin toward the center. The remaining parts of the mound were largely dug through by us.

At the very edge of the slope of the eastern side of the mound was the usual deposit of sherds and large fragments of vessels with whole vessels and others somewhat broken. This deposit continued in along the base until the former trench was reached, not far from the center of the mound, and was made up of vessels placed in the sand singly or in twos or threes. The deposit lay apart from the burials and was evidently a general one put in for the dead in common. Among the sherds some bore the check-stamp and a few examples of the complicated stamp also were present. All vessels had the basal perforation.

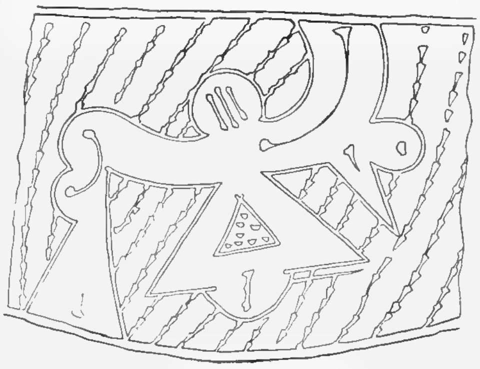


FIG. 113.—Vessel No. 1. Decoration. Mound near Strange's Landing. (Half size.)

Vessel No. 1.—A life-form representing a bird, ovoid in shape with circular

FIG. 114.--Vessel No. 2. Mound near Strange's Landing. (Eight-ninths size.)

FIG. 115.--Vessel No. 5. Mound near Strange's Landing. (About full size.)

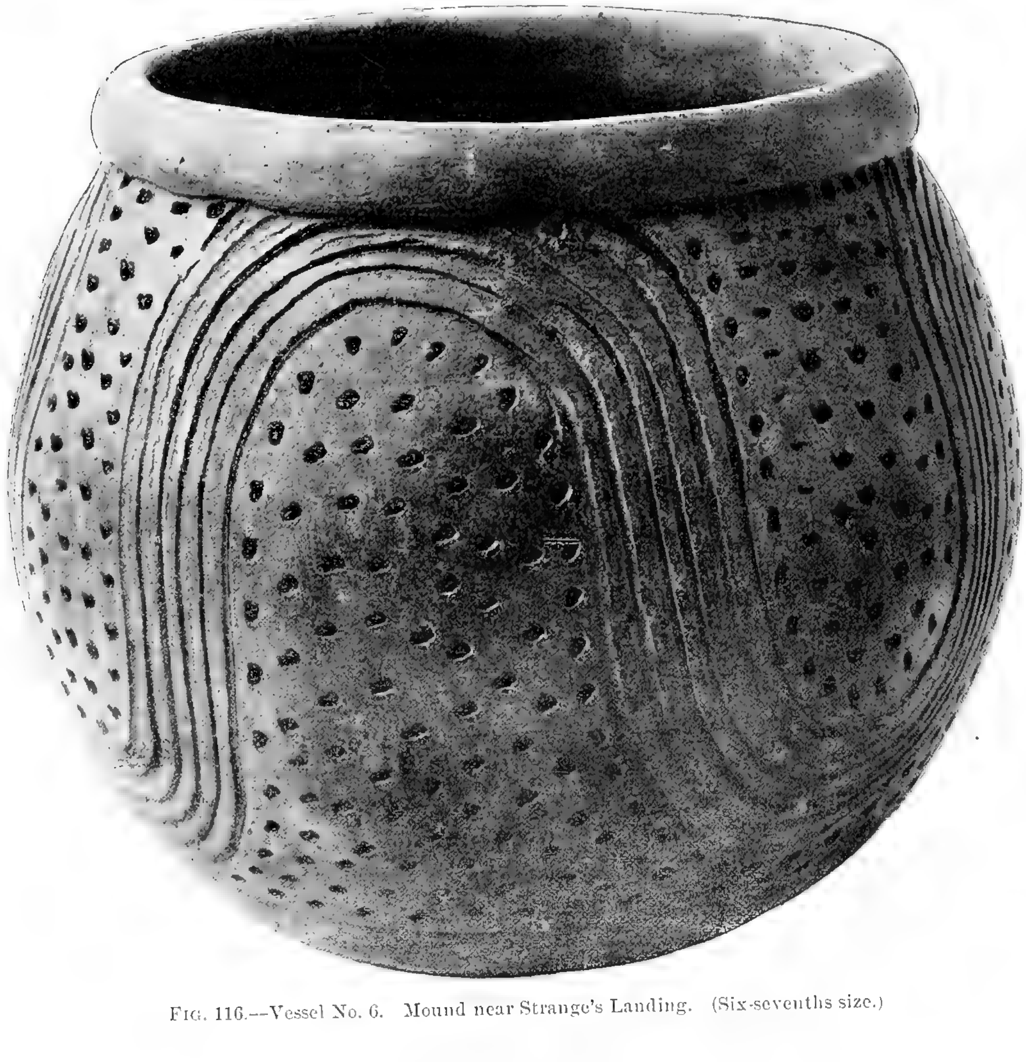


FIG. 116.--Vessel No. 6. Mound near Strange's Landing. (Six-sevenths size.)

aperture. The head projects from one end, the wings are circular and in relief; the decoration is punctate and incised (Fig. 112). The incised decoration representing the tail is shown in diagram in Fig. 113. Length, 7 inches; width, 5 inches; height, 4 inches.

FIG. 117.—Vessel No. 7. Mound near Strange's Landing. (Full size.)

Vessel No. 2.—Shown in Fig. 114 is another life-form, also a bird with projecting head and tail and incised and punctate decoration. The wings and legs are plainly shown. A part of the bill has been restored by us.

Vessel No. 4.—A gourd-shaped vessel, of excellent ware, with oval aperture, undecorated.

Vessel No. 5.—A bowl of light-colored ware, decorated on the upper part with

five crescentic figures enclosing a crosshatch design (Fig. 115). Maximum diameter, 7.5 inches; height, 3.8 inches.

Vessel No. 6.—A handsome globular vessel of about 2 quarts capacity, of excellent ware, decorated with a meander running through a field of punctate markings (Fig. 116).

Vessel No. 7.—In shape an inverted, truncated, four-sided pyramid with slightly rounded corners and edges. The rim, about 1 inch in breadth, projects inward horizontally (Fig. 117). The decoration, incised, is similar on two sides. Of the three different designs, one is simple crosshatch, one is shown in the half-tone, and the third is given diagrammatically in Fig. 118.

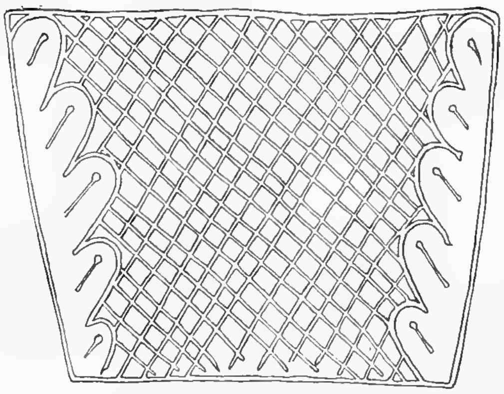


Fig. 118.—Vessel No. 7. Decoration. Mound near Strange's Landing. (Half size.)

But five burials were met with, and these were in the NE. and N. parts of the mound.

Burial No. 1.—In a shallow grave below the base was a skeleton closely flexed under oyster-shells, with the skull badly crushed, as were all found by us in this mound.

Burial No. 2.—A bunch of bones with four skulls, under oyster-shells.

Burial No. 3.—A closely flexed skeleton lying on the base of the mound, with no shells in association.

Burial No. 4.—In a shallow grave, closely flexed, was a skeleton with skull badly broken, but not sufficiently so to prevent evidence of flattening being apparent. This burial did not lie under oyster-shells, but was covered with a mass of small conchs (*Fulgur pugilis*).

Burial No. 5.—A closely flexed skeleton covered by sand alone.

A large and well-made "celt" lay within a few feet of one of the burials.

Mound near Baker's Landing, Calhoun County.

The mound, about 400 yards WSW. from the landing, East bay, is in hammock land, on property of Mr. Jonah Baker, living nearby.

The mound, which was 5 feet 4 inches high and 72 feet in basal diameter, had been woefully dug into. Besides several trenches, a hole in the center, 22 feet by 25 feet, involving the entire summit plateau, had been put down by former diggers. The eastern slope, however, was practically intact. Deep depressions at points adjoining the base of the mound showed whence material for its making had come. In an adjoining field was a shell deposit including a circular enclosure of shell, now almost ploughed away.

Nearly the remainder of the mound was dug through by us resulting in the finding of nine burials, all but one under considerable quantities of oyster-shells.

These burials were: one at full length on the back; one on the back, extended to the knees, the legs being flexed back; one flexed on the left side with the legs at right angles; one cut off at the knees by the aborigines in making another grave;

FIG. 119.—Sherd. Mound near Baker's Landing. (Four-fifths size.)

FIG. 120.—Sherd. Mound near Baker's Landing. (Half size.)

three too decayed for determination; scattered bones in shell above a burial; a single skull lying on the base of the mound, without the usual covering of shell.

While no skulls were in a condition to preserve, those in a partial state of preservation showed no flattening.

But one burial, the lone skull, lay in the eastern part of the mound, the others being mainly in the western.

A few sherds lay at the beginning of the eastern slope and farther in, here and there, the last near the center, were seven or eight vessels of inferior ware, all in fragments but two. The majority were undecorated, the check stamp and incised decoration not being found by us in this mound. Several bore complicated stamps, one of which resembles that on a sherd shown by us in Part I of this report as coming from the great mound at Walton's Camp. Two sherds with complicated stamp decoration are shown in Figs. 119, 120.

Larger Mound in Hare Hammock, Calhoun County.

St. Andrew's sound, so-called, is a long arm of water between the mainland and a narrow strip of land bordering the sea, known as Crooked Island. As these are the names made use of on the chart, we have adopted them, though the filling of a pass at the eastern end of the strip of water made it a sound no longer and joined Crooked island to the mainland.

The mound lay about one-half mile inland from a point near the eastern extremity of the sound, on property of Mr. Joseph Dyer, of Wetappo, Florida. The mound, which was pleasingly symmetrical, the usual truncated cone in shape, with a height of 7.5 feet and a basal diameter of 56 feet, had escaped the ravages common to the mounds of this district, partly through being more difficult of access than others, and partly through the presence of modern burials in the summit plateau. The only signs of previous digging were two or three small holes and a narrow trench on the western side, which continued superficially across the top.

The mound was levelled by us with the exception of a small part of the western margin and of a portion 10 feet square in the western part of the body of the mound, where modern burials were thickest. During a long period before our digging was discontinued no trace of earthenware or aboriginal interments had been found.

Aboriginal burials, as noted by us, numbered thirty-one and included, as to form, the lone skull; the bunch; close flexion on the side; one skeleton in a squatting position; scattered bones; and masses of bones continuing in on the same level. These masses, though each counted as one burial, in all cases represented a number of individuals.

Certain skulls showed flattening while in others it was not marked.

The first interment was found at the margin of the mound, almost due east and as the digging continued, burials were met with exceptionally as far to either side as north and south, though the great majority lay with a deposit of earthenware in the eastern and southeastern parts of the mound. No burial was met with farther than 16 feet from the margin.

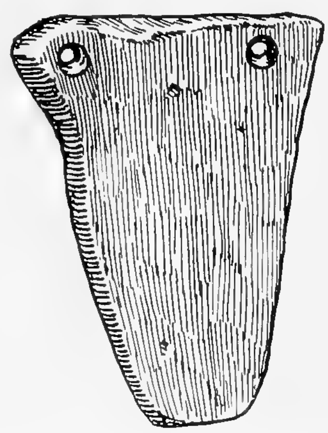


Fig. 121.—Gorget. Larger mound near Hare Hammock. (Full size.)

The burials in nearly every case lay beneath masses of shells, not oyster-shells, however, such as we have found to be the case in other mounds, but small conchs (*Fulgur pugilis*).

With a number of burials were shell drinking cups (*Fulgur perversum*), sometimes immediately on the skull, and with certain interments were "celts," two in one instance. In all, seven of these hatchets and part of another were met with, some not immediately with burials.

There were present also in the mound, exclusive of earthenware: a fossil shark's tooth; mica; a fragment of a graceful, barbed lancehead, 4 inches long; a gorget of ferruginous sandstone with two perforations for suspension (Fig. 121).

The earthenware of this mound was in better condition than usual in this district, while the decoration was much above the average. The deposit began in contact with the first burial in the eastern margin of the mound, as stated, and continued in about 15 feet, sometimes associated with burials and sometimes at a distance from them, but always in an area where they were most frequent. Incised and punc-

FIG. 122.—Vessel No. 1. Larger mound near Hare Hammock. (About five-sixths size.)

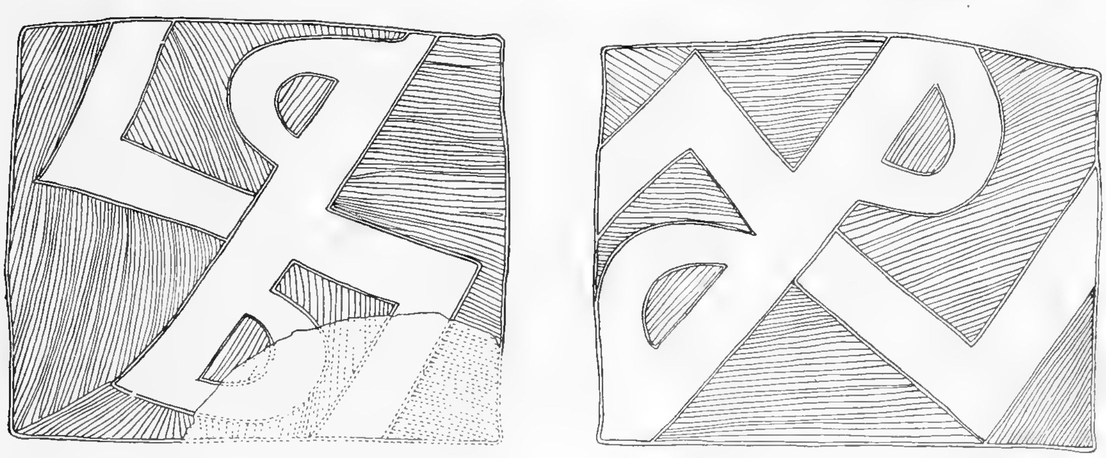


FIG. 123.—Vessel No. 1. Decoration. Larger mound near Hare Hammock. (Half size.)

tate decoration was largely represented; the complicated stamp less frequently; while the check stamp was found with a deposit of sherds in the beginning.

Of the twenty-four vessels met with by us, some of which were badly broken but have since been cemented and restored, we shall describe only the more noteworthy, omitting fragments with ordinary decoration and vessels of common type.

Vessel No. 1.—This vessel, shown in Fig. 122, is almost cubical, with the upper part inverted and ascending to an elliptical opening. On two opposite sides have been bird-head handles, one of which, missing when found, has been restored. The

FIG. 124.—Vessel No. 2. Larger mound near Hare Hammock. (About full size.)

decoration, incised, is nearly identical on two sides, one of which is shown in the half-tone. On the other sides are striking designs to a certain extent recalling the swastika. It will be noted by referring to the diagram (Fig. 123) that one-half of the swastika is represented on each design, but the remaining half not alone has its extremities in the form of loops, but these loops turn in the wrong direction. Length, 7.8 inches; width, 7 inches; height, 5.7 inches.

Vessel No. 2.—A handsome vessel of yellow ware with hemispherical body and inverted rim, on which is punctate decoration and two small horizontal projections. Somewhat below the rim there is an encircling projection, octagonal, tending slightly

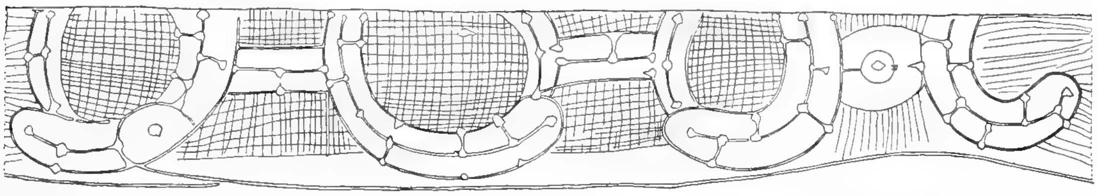


FIG. 125.—Vessel No. 2. Decoration. Larger mound near Hare Hammock. (One-third size.)

FIG. 126.—Vessel No. 6. Larger mound near Hare Hammock. (Full size.)

upward (Fig. 124). The decoration of the body, incised, not uniform, is shown in diagram in Fig. 125.

Vessel No. 4.—A pot with decoration about 2 inches broad below the rim, consisting of encircling rows of roughly triangular punctate markings, finely lined at the base.

Fig. 127.—Vessel No. 11. Larger mound near Hare Hammock. (Full size.)

Vessel No. 6.—An effigy-vase representing a male figure, which, in addition to several parts missing through early breakage, unfortunately lost one part of the head through a blow from a spade, necessitating restoration. The figure is in a squatting position with folded arms. A breech-clout encircles the loins and runs

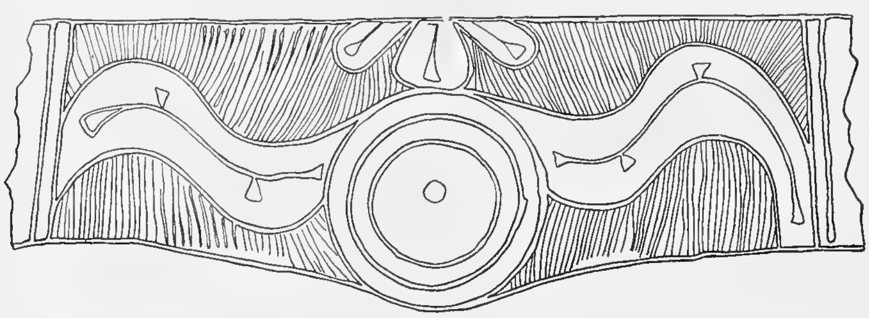


Fig. 128.—Vessel No. 11. Decoration. Larger mound near Hare Hammock. (Half size.)

between the legs. An unusual feature is that the head extends upward several inches above the rear portion of the vessel. The capacity is about 1 quart. There are four perforations for suspension (Fig. 126).

Vessel No. 8.—A bowl of somewhat over 1 quart capacity, triangular in hori-

zontal section with rounded corners. The sole decoration consists of two encircling incised lines about one-half inch apart, below the rim.

Vessel No. 9.—A vessel of about 1 pint capacity, undecorated, with globular body, slightly expanding neck and oval aperture. The rim has been elongated into two projecting points, one of which is missing.

Vessel No. 10.—A small, undecorated cup, the only vessel without basal perforation coming from this mound. It lay directly with human remains, somewhat beyond the area of the earthenware deposit.

FIG. 129.—Vessel No. 13. Larger mound near Hare Hammock. (About full size.)

Vessel No. 11.—A vessel of about 1 pint capacity, diamond-shaped with rounded corners, with aperture of similar outline and base almost flat (Fig. 127). The decoration, incised, shown diagrammatically in Fig. 128, covers one-half of the vessel and probably represents a bird with head and body much conventionalized.

Vessel No. 13.—A vase with globular body and flaring neck surmounted by a thickened hexagonal rim (Fig. 129). The decoration, incised and not uniform, is

shown diagrammatically in Fig. 130. Height, 4.8 inches; maximum diameter, 5 inches.

Vessel No. 14.—This unique vessel of excellent red ware, almost a truncated pyramid in form, has on one side a *repoussé* human figure standing with back turned to the observer, grasping with either hand the rim of the vessel (Fig. 131). The opposite side, showing the head and the face looking across the rectangular aperture, is shown in Fig. 132. The decoration on the two remaining sides of the vessel is given in Fig. 133. There are two holes, on the same side, for suspension.

Vessel No. 16.—A vessel of superior ware, in shape a truncated sphere, undeco-

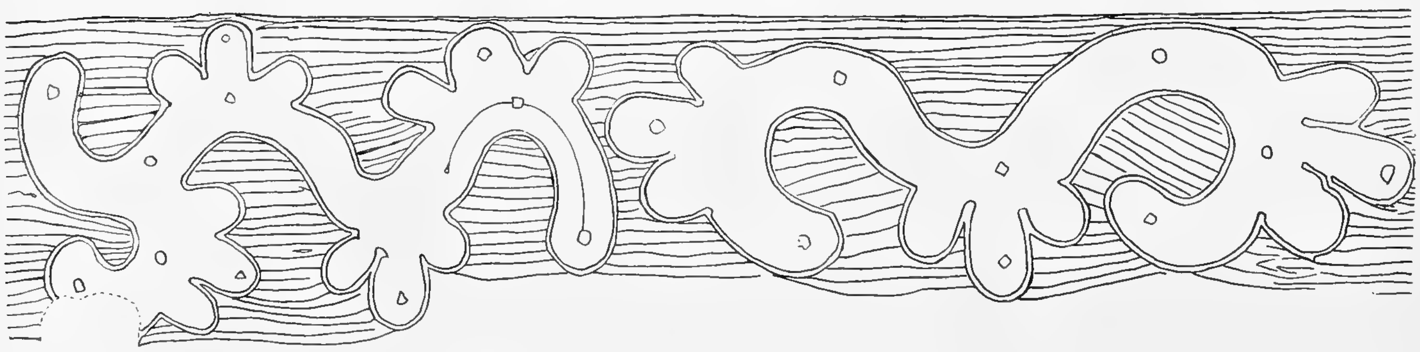


FIG. 130.—Vessel No. 13. Decoration. Larger mound near Hare Hammock. (Half size.)

rated as to the body. The rim, which bears four incised designs, is inverted and slightly depressed. Capacity about 3 quarts (Fig. 134).

Vessel No. 17.—A bowl of superior ware, of elliptical longitudinal section, with thick rim slightly projecting laterally and rounded points at either end. The decoration consists of crimson paint on the inside. Maximum diameter, 9.3 inches; width, 7.8 inches; height, 3 inches.

Vessel No. 18.—A thick bowl of excellent ware, undecorated save for traces of crimson pigment on the inside.

Vessel No. 23.—An interesting little vase with globular body and oblong aperture, having a duck's head in relief on each of two sides below the rim. The decoration on the other two sides, which probably represents wings, is almost identical. There are two holes for suspension (Fig. 135). Maximum diameter, 3.7 inches; height, 2.8 inches.

Vessel No. 24.—Globular body with flaring neck around which is a complicated stamp decoration.

Vessel No. 25.—Part of a vessel found in fragments. A portion of the body has been restored. The body, in addition to line and punctate decoration in which the bird symbol often appears, has been covered with crimson paint. From one side an object which seemingly projected somewhat, has disappeared. The opposite side, where, perhaps, was an identical object, was missing. From the rim on the back of the vessel projects an upright bird-head. In front, another head has a hollow bill to allow the passage of a liquid (Fig. 136). This feature is new in all our mound work.

FIG. 131.—Vessel No 14. Larger mound near Hare Hammock. (Full size.)

FIG. 132.—Vessel No. 14. Another position. Larger mound near Hare Hammock. (Full size.)

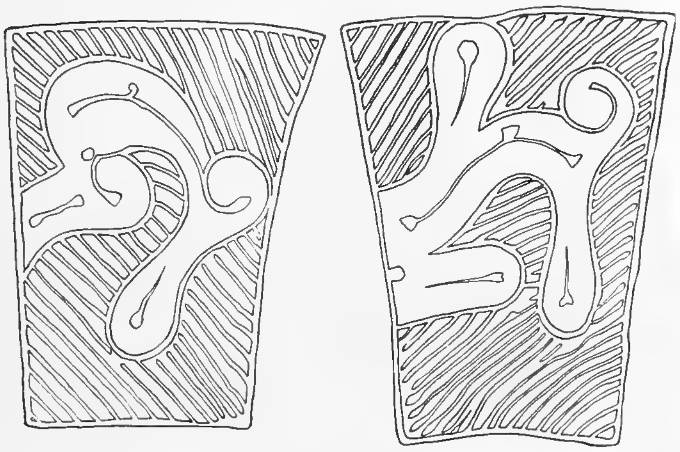


FIG. 133.—Vessel No. 14. Decoration. Larger mound near Hare Hammock. (Half size.)

FIG. 134.—Vessel No. 16. Larger mound near Hare Hammock. (Half size.)

FIG. 135.—Vessel No. 23. Larger mound near Hare Hammock. (Full size.)

SMALLER MOUND IN HARE HAMMOCK, CALHOUN COUNTY.

This mound, in dense growth of trees and vines, lay about 400 yards from the larger mound. Its basal diameter in an easterly and westerly direction was 50 feet and 36 feet in a northerly and southerly. It had escaped all previous digging.

Owing to unavoidable circumstances a portion of the eastern end only of the mound was dug by us. However, the earthenware deposit seemed to have come to an end sometime previous to our departure.

With a burial was a handsome weapon of light gray chert, 6 inches long and 1.7 inches in maximum width (Fig. 137).

Not immediately connected with human remains was a thick sheet of mica, roughly given the shape of a spearhead.

FIG. 136.—Vessel No. 25. Larger mound near Hare Hammock. (About full size.)

In the eastern margin were the usual sherds and vessels, broken and whole, of which the following will be particularly described.

Vessel No. 2.—A jar with flat base and body almost cylindrical, expanding slightly. There is slight constriction at the neck and upright rim. Below the rim is a band of rough complicated stamp decoration about 1 inch in breadth.

Vessels Nos. 3 and 4.—Small oblate spheroids found together. One has a decoration of rudely executed incised lines extending from margin to base. The other has carelessly executed incised and punctate decoration extending a distance of about 1 inch below the rim. Both vessels have perforations for suspension, on opposite sides, and both are imperforate as to the base, the only ones from this mound exempt from mutilation so far as noted by us.

Vessel No. 5.—A vessel of rather coarse ware, with an unusual decoration consisting of deep impressions at regular intervals over the entire surface. The base is

flat (Fig. 138). Height, 6.5 inches; maximum diameter, 4.8 inches; orifice, 1.4 inches.

A sherd from this mound, with complicated stamp, is given in Fig. 139.

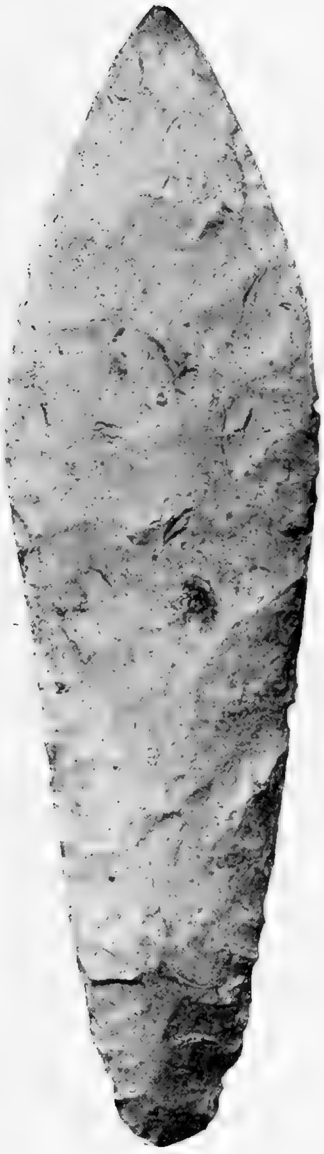


Fig. 137.—Weapon of chert. Smaller mound near Hare Hammock. (Full size.)

Fig. 138.—Vessel No. 5. Smaller mound near Hare Hammock. (Half size.)

Fig. 139.—Sherd. Smaller mound near Hare Hammock. (Three-fourths size.)

MOUND IN GOTIER HAMMOCK, CALHOUN COUNTY.

This mound, famous for successful relic searches in it, lay about one-half mile in NE. direction from Conch island, which is near the SE. extremity of St. Joseph's bay. The island is about one-quarter mile from shore and the mound about an equal distance farther in.

The mound, which has been practically dug to pieces, one relic hunter or treasure seeker filling the hole made by another, had been a truncated cone of dark sand. At the time of our visit, when it was completely demolished by us, its height was 5 feet; its diameter of base, 60 feet.

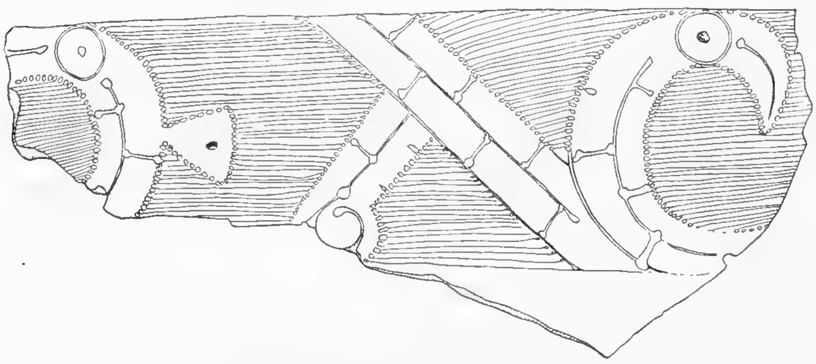


FIG. 140.—Decoration on a sherd. Mound in Gotier Hammock. (One-third size.)

Remnants of the mound found intact by us yielded a few bunched-burials. Several shallow graves below the line of the base, held human remains too badly decayed to determine positively the form of burial, though judging from the restricted lengths of the graves, they, too, contained the bunched burial. No artifacts were with the burials except a rude, undecorated, imperforate toy bowl.

FIG. 141.—Sherd. Mound in Gotier Hammock. (Three-fourths size.)

A coarse, undecorated pot of about three pints capacity, with basal perforation, lay alone.

A four-sided cup with flat base, of about 1 pint capacity, lay in the sand alone.

Unassociated, near the base, was a perforate vessel of about 3 quarts capacity, semi-globular body, upright and slightly flaring rim. Around the neck is complicated stamp decoration.

While all vessels from this mound were of most inferior quality, numbers of sherds were of excellent yellow paste and decorated with crimson paint or with incised designs, showing that the aborigines who built the mound could hold their own in pottery making with any in this region.

One sherd, shown in Fig. 140, lay with others in undisturbed sand.

In Fig. 141 is shown a complicated stamp design from this mound.

Mound near Indian Pass Point, Franklin County.

This mound, on property of Mr. James L. Smith, living nearby, lay among sand-blows and dunes near the Gulf shore, about three quarters of a mile in a WSW. direction from the Point. Its outline was irregular. Its height was difficult to determine owing to its irregular surface; perhaps 3 feet would be a fair average. The diameter of base E. and W. was 49 feet and 53 feet N. and S. A small amount of digging had been done by others shortly before our visit. The mound was totally demolished by us. It consisted of white sand, grayish sand, and yellow sand at the bottom with no regularity of stratification.

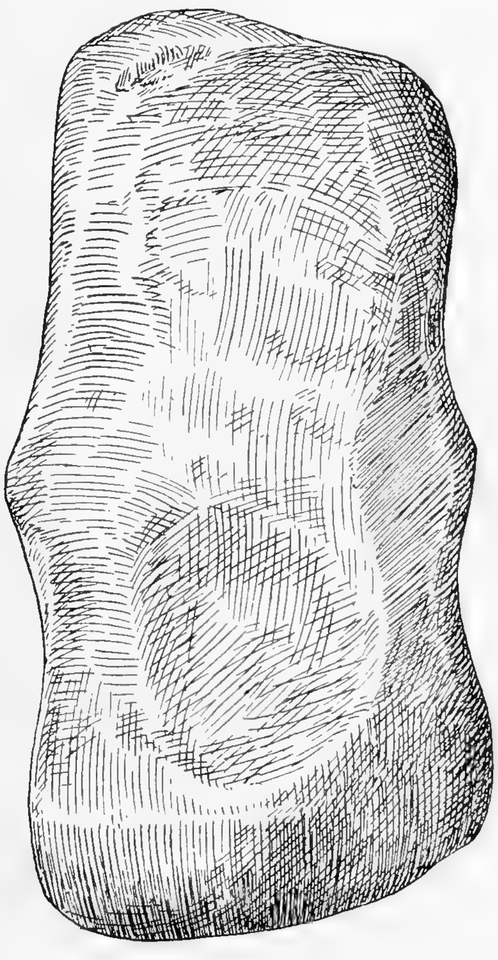


Fig. 142.—Hatchet. Mound near Indian Pass Point. (Full size.)

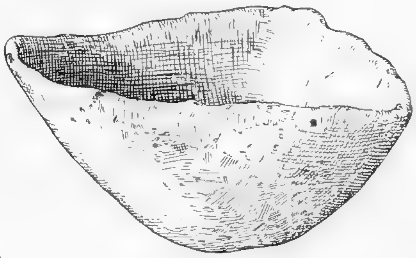


Fig. 143.—Vessel No. 1. Mound near Indian Pass Point. (Half size.)

Burials began at the extreme margin on the south side and in the southeastern part of the mound a little farther in. No burials were found in the western and northern parts until the central portion of the mound was reached.

The burials, which were all of the bunched variety, were very numerous but were not counted by us, as masses of loose bones often lay in contact with each other, making it impossible to say where one burial ended and another began. Many skulls had marked anterior and posterior flattening.

In this mound was no marginal deposit of artifacts, such as were found being

almost in immediate contact with burials. There were found: three pebbles lying with one pebble-hammer; conch-shells; several shell drinking cups; one *Fulgur perversum* of the heavy variety, with blunted beak showing use as a tool; a bit of hematite; a hone of ferruginous sandstone, roughly diamond-shape, 17 inches long and 8 inches in its broadest part; two arrowheads or knives, of chert; twenty-seven "celts," some gracefully wrought, others less carefully made. One of these differed markedly from the usual type in that places for fastening were evident on either side (Fig. 142).

The earthenware of the mound was of inferior quality in the main, and, with the exception of a few sherds, began at a considerable distance in. The check stamp was represented on fragments, but no ware bearing the complicated stamp came from the mound. One sherd of good quality showed part of a design in relief. Here and there, as the digging progressed, vessels, mainly undecorated, were found near the burials. At the center of the mound was a deposit of between fifteen and twenty vessels, the majority undecorated, many broken and so mixed as to prevent an exact count.

FIG. 144.—Vessel No. 2. Mound near Indian Pass Point. (Half size.)

The basal perforation is present in all the vessels from this mound, with two or three exceptions.

The most interesting ware will be described separately.

Vessel No. 1.—A three sided, rude, undecorated, imperforate bowl (Fig. 143). Height, 2.2 inches; maximum diameter, 4.5 inches.

Vessel No. 2.—Globular, with a small part missing through an early fracture which has been restored. The decoration is incised (Fig. 144). Maximum diameter, 7 inches; height, 5.7 inches; diameter of aperture, 4.5 inches.

Vessel No. 3.—Undecorated, an inverted acorn in shape. There are holes for suspension below the rim on opposite sides.

Vessel No. 4.—A vase rather heart-shaped in section as to the body, with flaring neck. The surface, with the exception of the neck, is covered with incised decoration including the bird symbol, often repeated. A rudimentary head extends above the rim on one side (Fig. 145). The decoration, shown diagrammatically in Fig. 146, is repeated on the opposite side. Height, 6 inches; maximum diameter, 5.6 inches.

FIG. 145.—Vessel No. 4. Mound near Indian Pass Point. (About full size.)

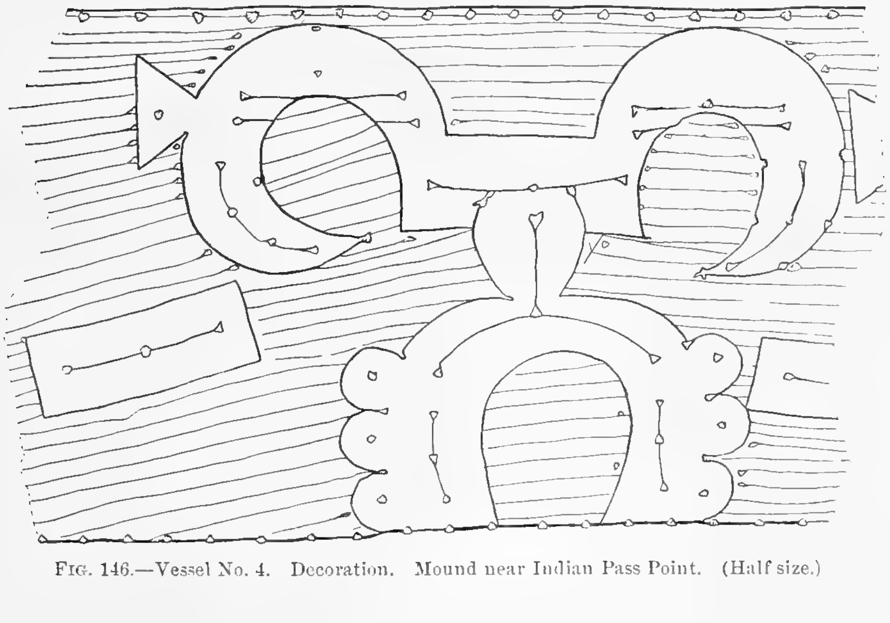


FIG. 146.—Vessel No. 4. Decoration. Mound near Indian Pass Point. (Half size.)

Vessel No. 5.—A truncated globe with rude incised decoration consisting of groups of parallel perpendicular lines about 2 inches long, each group somewhat less than 1 inch apart. This vessel has a capacity of somewhat over 1 quart.

Fig. 147.—Vessel No. 6. Mound near Indian Pass Point. (Half size.)

Vessel No. 6.—A quadrilateral vessel of one quart capacity, with rounded aperture and flat base has for decoration, series of zigzag lines (Fig. 147).

Vessel No. 7.—A quadrilateral vessel of heavy ware, with flattened base and rounded corners, of about 2 quarts capacity. The neck, about 1 inch in height, is upright.

A little below the surface, not associated with human remains, was part of an old-fashioned chisel-pointed spike of brass, of a kind formerly used in ship-building.

Mound at Eleven Mile Point, Franklin County.

This Point, on St. Vincent's sound, taking its name from its distance from the town of Apalachicola, has on it a mound on property of Mr. G. A. Patton, resident on the place. There are various shell deposits in the neighborhood and heaps of shell extend for a distance along the shore.

Fig. 148.—Sherd. Mound at Eleven Mile Point. (Three-fourths size.)

Fig. 149.—Sherd. Mound at Eleven Mile Point. (Two-fifths size.)

The mound, in woods on the verge of a cultivated field, was seamed with trenches and riddled with holes, most of which, however, were superficial.

What was left of the mound had a basal diameter of 50 feet; a height of about

3 feet. The mound was completely demolished by us. Beginning at the very margin of the southeastern portion, unassociated with burials, which were more centrally located, were various vessels, singly or in pairs, and parts of vessels and numerous sherds. These offerings extended a number of feet in toward the center.

FIG. 150.—Vessel of earthenware. Mound at Eleven Mile Point. (Half size.)

FIG. 151.—Vessel of earthenware. Mound at Eleven Mile Point. (Half size.)

FIG. 152.—Vessel of earthenware. Mound at Eleven Mile Point. (Half size.)

Still farther in, usually apart from interments, were several other vessels in different parts of the mound. Sherds were undecorated; incised, sometimes with cross-hatch; or, in several cases, had a complicated stamp. Two of these are shown in Figs. 148, 149. Several vessels also bore the complicated stamp and all had the basal perforation.

We shall describe in detail the most noteworthy vessels.

A compartment vessel with circular division in the center, in a plane above four similar compartments, one of which, missing when found, has been added, with the aid of a mixture composed of beeswax, whitelead, powdered soapstone, resin, linseed oil, and turpentine, which we have found very useful in work of this kind. This vessel has been sent to the Peabody Museum, Cambridge, Mass.

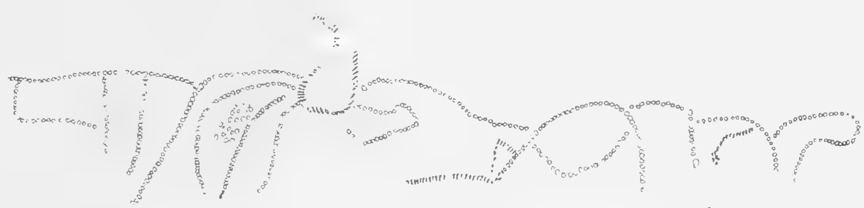


FIG. 153.- Decoration on vessel of earthenware. Mound at Eleven Mile Point. (One-third size.)

A four-sided vessel of about one-half pint capacity, otherwise undecorated, has small protuberances at each upper corner of the body and companion ones on the rim immediately above. The ware is inferior.

A vessel with semiglobular body and short incurving neck has incised decoration as shown in Fig. 150. The capacity is about 1 pint.

A vessel of eccentric shape, somewhat resembling that of a dumb-bell, undecorated save for an encircling incised line below the rim, has two holes for suspension on opposite sides (Fig. 151).

A bottle with neck curiously disproportionate in length, of inferior ware and rudely made, has a height of 6.7 inches, a maximum diameter of 3.6 inches (Fig. 152).

A vessel made to hold about one quart, has a semiglobular body and a slightly flaring neck about 1.25 inches in height. There is a curious punctate decoration shown in diagram in Fig. 153.

Cool Spring Mound, Apalachicola, Franklin County.

In the western outskirts of Apalachicola is a mound which, as might be expected, has long been the center of attack for avaricious or curious persons. Material from one trench or excavation has been thrown into others, thus preserving the mound from demolition. Its present height is about 7.5 feet; its diameter of base, about 90 feet. On the surface of the mound, where former diggers had thrown them, were many sherds much resembling in material and ornamentation the ware we found during our preceding season's work between Perdido and Choctawhatchee, bays, including a part of a vessel in the form of a frog.

About two-thirds of the mound were dug down by us including much disturbed material. On the base of the mound and two or three feet above it were a number of burials consisting of trunks of skeletons extended on the back with thighs and legs sometimes drawn up against the body or drawn up at right angles to the trunk, or extended laterally. These forms, with slight variations, were met with nine times, and burials disturbed by our own or by former diggers indicated a like method of burial. A single skull and a skull with a humerus were found. No bones were in a condition to preserve. The only artifacts encountered with burials were a bit of mica with one skeleton and a well-made lance-head of chert, 4.75 inches in length, beneath the chin of another.

In the marginal part of the mound, which had been dug through by others, were many sherds: undecorated; with incised and punctate decoration, sometimes in combination; the complicated stamp, in a few cases; the check-stamp, once or twice; looped handles; handles representing heads of quadrupeds or of birds; animal legs in relief on the sides. Deeply scalloped margins were abundant.

A "celt" lay unassociated in the sand.

Mound near Apalachicola, Franklin County.

In a cultivated field, about one-half mile in a westerly direction from the town, on property of the Cypress Lumber Company, of Apalachicola, is a mound much spread by the plow. Its diameter of base is about 100 feet N. and S. and 80 feet E.

and W., approximately. The height is about 2 feet. Nearby is a shell-field while a shell-heap of considerable size is distant about 75 yards in an ENE. direction.

Ten excavations in various parts of the mound yielded no result other than to show the mound to have been built of sand on a base of shell, presumably as a place of abode.

Cemetery Mound, Apalachicola, Franklin County.

This mound, in Magnolia Cemetery at Apalachicola, about 5 feet high, was demolished by us, with the courteous permission of the City Council.

The mound, the usual truncated cone, was composed of white sand in places and of grayish sand in others, with oyster-shells centrally, near the base.

The mound, which had sustained much previous digging, seemingly, contained but two whole skeletons and three others from which parts had been cut away.

Unassociated, was a circular ear-plug of lime rock, covered with sheet copper on one side, with a diameter of 1.6 inches, of the type figured by us in a former report as coming from Mt. Royal, Fla.

In midden refuse, near the base, was a bone pin about 8 inches long and from the same deposit, as a rule, came a number of sherds, undecorated or bearing the check stamp.

Pierce Mounds, near Apalachicola, Mound A.

The Pierce Mounds, five in number, lie from 1 mile to 1.5 miles to the westward of Apalachicola, on property belonging to Mr. Alton Pierce of that place.

Mound A, the southwesternmost of the group, which had undergone but insignificant previous digging, had at base a diameter of 96 feet E. and W. and 76 feet N. and S. The diameters of the summit plateau in the same directions respectively were 40 feet and 34 feet. The plateau, however, had been much broadened and the height of the mound somewhat reduced to prepare for interments made in recent times. The height of the mound which was completely demolished by us, was 8 feet.

The body of the mound was of yellow sand, the basal portion being of sand discolored by fire and by organic matter, often mixed with oyster-shells. There was no regular stratification, but irregular layers of oyster-shells were present throughout, in places.

Throughout the mound it was noted that the great majority of burials lay in shell, but it seemed to us that this was owing to the fact that the majority of burials were well down toward the base where the shell was, rather than that the association was intentional. Such burials as were higher in the mound usually lay in the sand.

As the mound was practically undisturbed at our coming, data as to burials were taken with great care. The relative position of the ninety-nine found by us, which, however, stand for a much greater number of skeletons, is shown in the plan (Fig. 154). We may say here, and it applies to all other mounds opened by us, that when enough of a bone remains to make its identification certain, we often speak of it as present, for the reason that it was there when the burial took place. Also, when we write of skeletons in mounds, we do not wish to imply that these skeletons were

FIG. 154.—Plan of Mound A. Pierce mounds, near Apalachicola.

interred covered with flesh, but rather, after being exposed for a period, as was the custom with southern aborigines, that they were buried without the flesh but in the main held together by ligaments. Missing bones or bones misplaced, occasionally, show this to be true.

Heads of skeletons pointed in all directions. A few skeletons were closely flexed. The majority, however, had the thighs at right angles to the trunk, with legs drawn up toward the thighs. Unless especially noted, burials were as follows: flexed on the left side, 33; flexed on the right side, 25; flexed on the back, 3; full length on back, 2; infants' skeletons, badly decayed, 2; skulls with fragments of

FIG. 155.—Vessel with Burial No. 2. Mound A. Pierce mounds, near Apalachicola. (About full size.)

bone, 3; lone skulls, 3; scattered remains, 9; aboriginal disturbance, 1; recent disturbance, 1; skull in caved sand, 1.

The following are not included in the above.

Burials No. 7 to No. 17, inclusive, a group comprising eleven skeletons variously flexed with skulls pointing in different directions, but mainly toward the central part of the mound. These skeletons were in a layer of shell, from 1 foot to 1.5 feet in thickness, about 1 foot above the base. With this shell, above the bodies, were blackened masses composed of charcoal, calcined shell, ashes, etc. These masses did not seem to be remains of fires which had been made and allowed to burn at the

places where the ashes and charcoal were found, but to have been brought while still burning and placed on or near the skeletons, as such bones only were charred as were in contact with the material. None of the bones was calcined, nor did the sand and shell about these masses of material show evidence of fire. Thoughout the mound were many such places, showing the use of fire away from the mound during the ceremony of interment.

Burial No. 39, a mass of human bones, including seven skulls, lay in the body of the mound, with remains of fire above and sand mixed with shell below.

FIG. 156.--Vessel with Burial No. 2. Mound A. Pierce mounds, near Apalachicola. (Two-thirds size.)

Burials No. 42 to No. 45, inclusive, four skeletons at full length, side by side in a shallow grave beneath the base, with heads in the same direction.

All bones in this mound were in bad condition through decay, but one skull being saved.

Belonging to Burial No. 52 was a femur showing a repaired fracture of the upper third, with some shortening of the bone. This was sent to the United States Army Medical Museum at Washington, D. C.

Seldom before have we found a mound so full of promise as to yield of artifacts at the start, and so disappointing during the remainder of the investigation.

Burial No. 2, (see plan) a skeleton partially flexed on the left side, lay in the northern slope of the mound, 2.5 feet from the surface. Under the thorax were many fragments of part of a vessel with a decoration of incised lines, and crimson paint in places. Three feet to the west was a vessel, upright, of about six quarts capacity, of undecorated ware, in fragments through pressure of sand.

FIG. 157.—Vessel with Burial No. 2. Another view. Mound A. Pierce mounds, near Apalachicola. (Two-thirds size.)

Immediately back of this one was another of about the same size, undecorated, with part of the bottom knocked out. About 1 foot farther in the mound, on its side, lay a vessel of yellow paste with two compartments, one of which, crushed by sand and roots, has been cemented together. The decoration consists of incised lines and bands of crimson paint as shown in Fig. 155. But one compartment has the basal perforation. Height, 4.6 inches; maximum diameter, 7.1 inches; diameter of a single aperture, about 3 inches.

In contact with this double cup was a curious spiral vessel shown in two positions in Figs. 156, 157.

Though this vessel, at first glance, resembles a ram's horn, we do not believe it to have been modelled after one.

In the first place, it is our opinion that the origin of the vessel antedates the appearance of sheep in Florida.

Secondly, there are marked points of difference in appearance between the vessel and the horn of a ram. The corrugations are not encircling but leave a smooth space the length of the lower part of the vessel. The distal end is rounded and does not taper to a point as is the case in a horn. As to the aperture, we must bear in mind it is open, of necessity, and may not be called upon to bear testimony as to resemblance.

There are grub-worms in Florida as long as, or longer than, the little finger of a male hand and fully equal in diameter. Their extremities are rounded. The deep corrugations covering their backs and sides end at the belly. As these worms lie dead on the surface, we have seen them in the exact position shown in the vessel. Besides, worms were of some importance along the Gulf coast in early days, being an article of diet at times, according to Cabeça de Vaca.

We are convinced, then, that this vessel represents a life-form and is modelled after the grub-worm. Height, 6.9 inches; maximum diameter of body, 2.9 inches; diameter of opening, about 3 inches; width of entire vessel, 7.8 inches.

About 6 inches distant from the worm-effigy were four arrowpoints or knives, in association, three of chert, one of quartzite, while 10 inches to the south were fragments of an almost cylindrical vessel of yellow ware. The base, which had been flat, is missing. The decoration, punctate and lined, has crimson paint in places, distinguishable in the half-tone (Fig. 158). The diagram (Fig. 159) shows, with other symbols, a pair of open hands, the backs turned outward, the thumbs thrust back. Maximum diameter, 5.1 inches; diameter of opening, 4.3 inches; height of vessel, 5.3 inches.

The widespread emblem of the open hand was found by Mr. Cushing on a mussel shell, among his wonderful discoveries at Marco, and the open hand appears on a vessel from Alabama.[1]

Considering the comparatively large number of burials but few articles lay immediately with the dead.

With Burial No. 60, two skulls with certain bones mingled, lay a "celt" about 11 inches in length, immediately beneath one of the skulls.

Burial No. 63, a skeleton flexed at about right angles on the right side, had near it a beautifully smoothed pendant of a fine grained slate rock, 6.5 inches in length, .6 of an inch in maximum diameter, grooved at one end for suspension, of a type to be figured later in the account of the Yent mound.

In a grave, beneath the eastern slope of the mound, 6 feet below the surface, lay Burial No. 66, flexed at right angles on the left side. Along the right humerus

[1] Report Bureau of Ethnology. 1882–83, p. 433.

FIG. 158.—Vessel with Burial No. 2. Mound A. Pierce mounds, near Apalachicola. (About full size.)

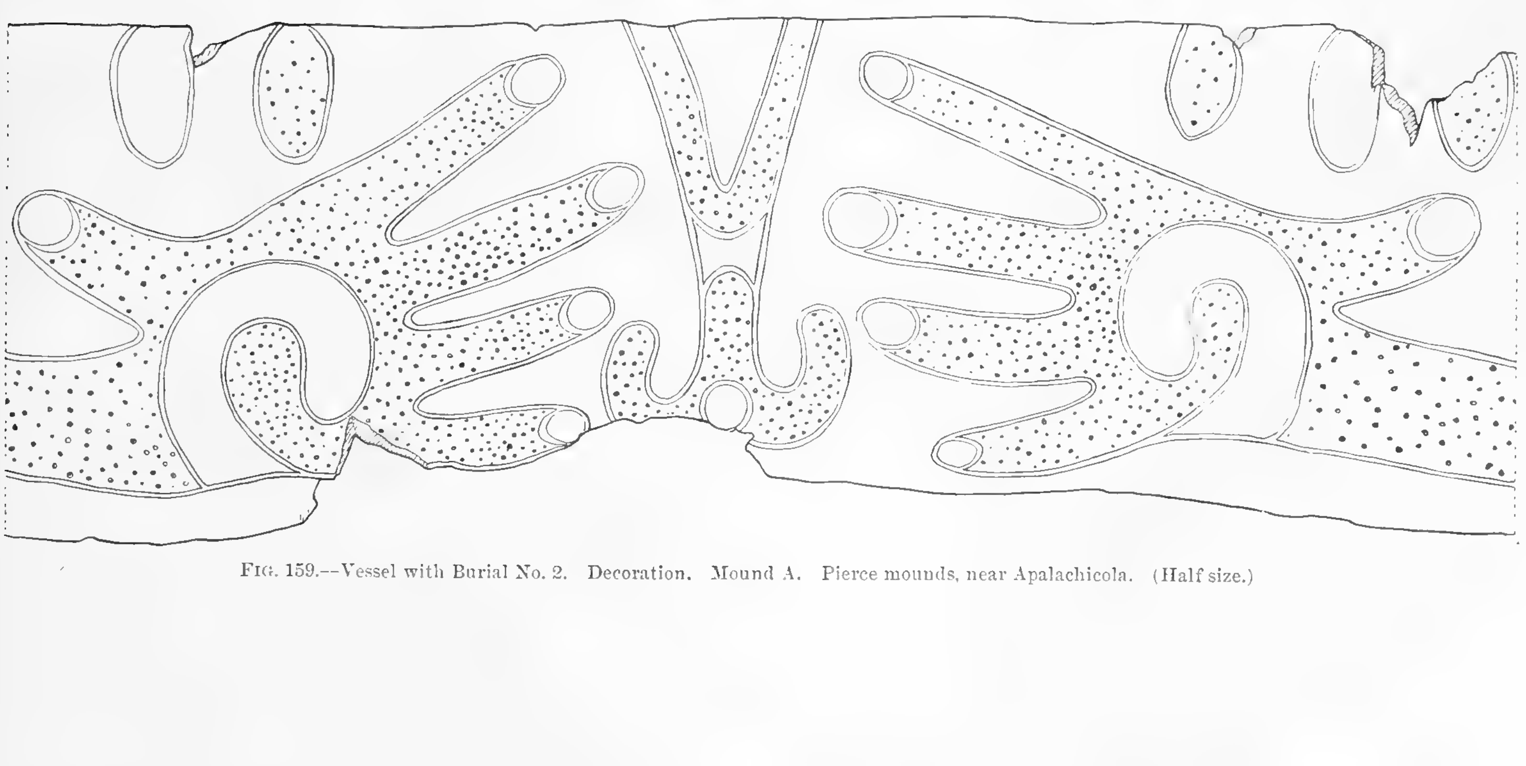


FIG. 159.—Vessel with Burial No. 2. Decoration. Mound A. Pierce mounds, near Apalachicola. (Half size.)

lay an ornament of sheet copper, 10 inches long and 1.7 inches broad, bent around and overlapping on itself, making a flat tube about .8 of an inch in diameter. The metal, almost entirely transformed into carbonate, fell into bits upon removal. At the neck of the skeleton were found perforated pearls and fragments of others.

Burial No. 81, a skeleton flexed to the right, on the base, 8 feet below the surface, had, at either shoulder a disc of sheet copper so badly carbonated and corroded that the original size could not be determined.

At the center of each of the sheet copper discs, on one surface, is a layer of silver. This layer is not fairly thick, and regular as to its margin as would be the case if a coin or sheet silver had been shaped and fastened on, but is very thin and radiates marginally as though a small nugget, placed on the copper and hammered out, had remained through force of the blows.

We are indebted to Mr. Warren K. Moorehead, whose great discovery of copper objects of aboriginal make in the Hopewell mounds, Ohio, is so well known, for the information that several ornaments of sheet copper were found in the Hopewell altars, which were covered with a thin layer of silver. These may be seen in the Field Columbian Museum, Chicago.

While the existence of sheet copper ornaments of purely aboriginal provenance is now admitted by all who possess a schoolboy's knowledge of chemistry,[1] the presence of silver in a mound, as a rule, shows "white contact" on the part of the aborigines who built the mound, but such is not always the case. Silver is sometimes visibly present in "Lake" copper which is native and Lake Superior is known to have been the main source of aboriginal supply of copper. To cut this free silver from the native copper would be easy, though the supply would be small. Mr. Moorehead informs us that he found in the effigy mound of the Hopewell group a bit of native silver, hammered flat, which is now in the Field Columbian Museum. No indication of contact with Europeans was present in the Hopewell mounds.

While Mr. Moorehead was conducting investigations in 1897 for the Ohio State Archæological and Historical Society, in Pickaway County, Ohio, in a small stone box were found five nuggets of silver, weighing six and one-quarter ounces, in the aggregate. This unique discovery shows the aborigines to have been possessed of silver nuggets in all probability before the coming of the whites, since no artifact of European make was met with during the work.

The method of fastening the silver on the sheet copper ornaments found by us, and the irregular outline and thinness of the hammered silver would, in our opinion, argue aboriginal workmanship and a supply more scanty than would have been the case had silver bullion and coins been forthcoming from the whites through barter or through shipwreck. When to these facts we add that no object surely of white provenance came from the mound in which these ornaments were, there are good grounds to consider these copper and silver ear-plugs to be of purely aboriginal make. They are the first of the kind to be found in Florida, we believe.

[1] "As to Copper from the Mounds of the St. Johns." "Certain Sand Mounds of the St. Johns River, Florida," Part II. By Clarence B. Moore.

A few shell beads lay near a skeleton of an infant.

With Burial No. 93, a skeleton flexed on the left side, were a few shell beads near the neck, and at the shoulder, an undecorated, imperforate vessel of about one-half pint capacity (Fig. 160).

FIG. 160.—Vessel with Burial No. 93. Mound A. Pierce mounds, near Apalachicola. (Half size.)

A burial had a sheet of mica near the head.

Certain scattered bones lay in sand colored with hematite.

Loose in the sand were: a number of drinkingcups wrought from *Fulgur perversum*, several with perforated bases; two arrowheads or knives, of chert; a rude chipped chisel of chert; a small pendant rather roughly made; the usual quota of hammer-stones, pebble hammers, pebbles, broken hones, etc.; two pointed implements made from the axis of *Fulgur;* a few shell beads in caved sand; also in caved sand, a fragment of sheet copper with fluted decoration, badly carbonated; on the base, among the shells, a gorget of bone, elongated oval, made from the femur of a bison,[1] perforated for suspension at one end, 7.1 inches long, 2 inches in maximun width (Fig. 161).

FIG. 161.—Gorget made from the femur of a bison. Mound A. Pierce mounds, near Apalachicola. (Full size.)

Also unassociated was a small vessel with globular body, constricted neck and flaring rim around which is a series of notches. A rude meander decoration surrounds the body. One of four feet is lost through a basal perforation.

In debris was part of a smoking pipe of earthenware of the platform, or "Monitor," type.

A curious fragment of earthenware lay alone in the sand. The decoration is partly incised and partly made with a crescentic point. Two and five-tenths inches are of solid ware; above seems to be the beginning of the base of a cup (Fig. 162).

In fallen sand in the SSE. slope of the mound was a globular vessel of about 1 quart

[1] Kindly identified by Prof. F. A. Lucas of the U. S. National Museum.

capacity, in pieces which have since been cemented together. The base is perforate. The decoration consists of upright parallel bars of crimson paint rudely applied. With this vessel were many fragments representing parts of three or four vessels, all decorated with crimson pigment. In association with these was a vessel with the rim slightly broken, which, at first glance, seemed to be an upright cylindrical cup placed within a bowl. Around the body and even on the base is a repetition of an incised and punctate design with crimson pigment, in addition. The neck is crimson inside and out. There is a basal perforation (Fig. 163). Height, 5.2 inches; maximum diameter of body, 4 inches; diameter of opening, 3 inches.

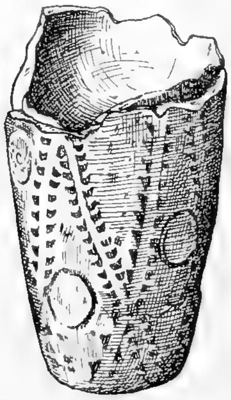


Fig. 162.--Sherd. Mound A. Pierce mounds, near Apalachicola. (Half size.)

With fragments of ware were a small undecorated

Fig. 163.--Vessel of earthenware. Mound A. Pierce mounds, near Apalachicola. (Full size.)

FIG. 164.—Vessel of earthenware. Mound A. Pierce mounds, near Apalachicola. (Five-sevenths size.)

imperforate pot with four feet and a rude vessel of about 1 quart capacity, with flaring rim and seemingly cord-marked decoration. Three of four feet have been removed by a basal perforation.

FIG. 165.—Sherd. Mound A. Pierce mounds, near Apalachicola. (Half size.)

Unassociated, in the eastern slope of the mound, lay the wreck of a curious, undecorated vessel of very inferior ware, which has since been restored. The body is annular and flattened and has at equidistant points three necks resembling inverted truncated cones (Fig. 164). Diameter of body, 6.2 inches; central opening, 2 inches.

A sherd with a complicated stamp of a pattern new to us is shown in Fig. 165.

Together, near a great fireplace, on the base of the mound, were: a shell drinking cup; two canine teeth, one of which Prof. F. A. Lucas has identified as the left lower canine of a wolf, *Canis*

occidentalis, and the other as the left lower canine of a puma, *Felis concolor;* and a shell (*Glycymeris americana*, Defr.). Near these or with them were: many fragments of deer bones; one canine of a carnivore; part of a lower jaw of a small rodent; a mass of shell, resembling a large imperforate bead; a rude shell gouge.

A neatly made gouge of shell, with the upper end missing, lay unassociated in the sand.

Pierce Mounds, near Apalachicola, Mound B.

This mound, with a height of 16 feet and a basal diameter of about 100 feet at the present time, showed traces of previous digging on every side. In addition, much of the marginal parts had been hauled away for use in an adjoining cultivated field. On this mound were many palmettoes, much prized by the owner, which precluded a full examination. Such work as was done at various points showed the mound to be of sand with slight admixture of shell. A superficial skeleton lay near the margin.

About fifty yards eastward of Mound B, in a field covered with scattered shells, some trenching was done by us resulting in the discovery of three skeletons at full length. Our work here was discontinued at the request of the owner, who did not wish to have unproductive soil brought to the surface.

In this field is a mound commonly believed to be of shell throughout. It is said by some that the shell extends to a depth of about 2 feet only, after which sand is encountered. As the shell is used for the streets of the town, digging into the mound is not encouraged.

Pierce Mounds, near Apalachicola, Mound C.

This mound, elliptical in outline, with flat top, about 6.5 feet high, has a diameter of 90 feet east and west and of 74 feet north and south.

Starting from the margin, a trench 35 feet long and from 13 feet to 15 feet wide, was continued to within 3 feet of the center. Part of the way, the trench was run along the base of the mound, but it having become evident that the mound was built upon a shell-heap, the useless throwing back of shell was discontinued and the sand alone was removed.

Three skeletons were met with, two flexed, and one, that of an infant, disturbed by the digger. With this skeleton were a few small shells used as beads.

Loose in the sand were various sherds with small check stamp. Pinched decoration and complicated stamp also were represented. One small sherd bore semicircular impressions made, perhaps, by a portion of a reed.

Pierce Mounds, near Apalachicola, Mound D.

This mound, in thick scrub, has a height of 20 inches. The diameter of base is 40 feet. It is composed of sand blackened with organic matter and has local layers of shells of the oyster and of the clam.

The mound, which was about one-half dug away, proved to be a dwelling site. Sherds of good quality, some with pinched, some with incised, decoration, but mainly of the small check stamp, were present.

Pierce Mounds, near Apalachicola, Mound E.

This mound, which is much spread, has basal diameters of 76 feet N. and S. and 82 feet E. and W. The height is 3.5 feet.

Fourteen holes, each about 3 feet square, were dug to the base. The mound is composed of sand of various shades without admixture of shell. Nothing was found save a single fragment of pottery. The mound was evidently domiciliary.

Singer Mound, near Apalachicola, Franklin County.

This mound, totally demolished by us, was about 1.5 miles in WNW. direction from Apalachicola in a cultivated field, the property of the late Mr. Joseph Singer of that place.

The mound, almost intact, the usual truncated cone in shape, had a height of 5.5 feet; a diameter of base of 65 feet.

The upper portions were of white sand, which probably was the yellow sand of the middle parts of the mound, bleached by sun and rain. Above the base was a stratum of sand blackened by fire, increasing in thickness until the maximum, about 2.5 feet, was reached in the central part of the mound.

Burials, nineteen in all, were met with from the marginal parts of the mound to the center. The bones, as a rule, were so decayed that parts only remained. A few burials were in better condition.

Burial No. 15, the skeleton of a young person, lay in the black layer near the base and was the only burial found at a depth greater than 2.5 feet from the surface. This skeleton was partly flexed on the left side.

Burial No. 10 had been held together in part by ligaments, much of the skeleton being in order, though part of a scapula lay with the legs. Over this skeleton were a few oyster-shells, as was the case with a number of burials in this mound.

Burial No. 14 was a skeleton at full length on the back with certain other human bones lying across the legs.

All other burials were fragmentary. Several lone skulls were met with, and once an isolated portion of a femur.

No pottery came from this mound with the exception of a few sherds, undecorated or with the check stamp, evidently introduced with the sand.

Two gracefully wrought celts, each about 8 inches in length, lay separate and unassociated.

Jackson Mound, near Apalachicola, Franklin County.

About 2.5 miles in a WNW. direction from Apalachicola, in the verge of woods, on property of Mr. Scipio Jackson, colored, resident on the place, was a mound which was completely demolished by us. This mound, made of sand of vari-

ous colors, irregularly placed, had a height of 9 feet. Its basal diameter N. and S. was 72 feet and 66 feet E. and W. Six excavations, all insignificant, had been made previous to our visit.

A feature of the mound was the comparatively central position of the burials. With the exception of a small pocket of calcined fragments of human bones, no trace of human remains was met with until a point 15 feet from the center of the mound was reached, and the majority of the twenty-six burials noted by us were still more central.

Fig. 166.—Smoking pipe of earthenware. With Burial No. 3. Jackson mound. (About full size.)

All burials were badly decayed, sometimes only crowns of teeth, small bits of unidentified bone and even mere traces of bone, remaining in the sand. Single skulls, skulls with a few long-bones and certain long-bones without a skull, were present.

Burial No. 2, a skull and parts of two long-bones, had in association sand colored with hematite and four arrowheads or knives, of chert.

Burial No. 3, a crushed skull on certain long-bones, better preserved than other burials in the mound, lay at a depth of 18 inches from the surface. With this burial were a bit of pottery, one pebble and two smoking pipes of earthenware. One of these pipes (Fig. 166), ornamented around the margin of the bowl and at the base,

has a diameter of bowl of 3.5 inches. The other, with a small, rude decoration of incised lines, is 2.5 inches across the bowl, within which is carbonized material, tobacco or a substitute for it (Fig. 167). As the other burials in the mound were at considerable depth, some lying on the base, it is possible that this burial was intrusive, especially as the bones were in so much better condition than the others in the mound. We may say that the presence of smoking pipes with a burial would not of necessity prompt us to consider it a recent interment, since we are convinced that

FIG. 167.—Smoking pipe of earthenware. With Burial No. 3. Jackson mound. (Full size.)

pipes were in the possession of the aborigines long previous to the coming of the whites. We have personally found pipes in too many mounds in which no article of European make was present, to come to any other conclusion, and it is our belief that a contrary opinion is held by those only who have never engaged in field work.[1]

With the exception of a hammer-stone with one burial and a large, flat pebble with another, no additional artifacts were found with the dead, though it is our belief that certain pockets of very dark sand near the center of the mound, near which objects were met with, were places where burials had been.

In sand blackened by organic matter, 5 feet from the surface, lay a hammer-stone with a small corroded disc of sheet copper or of brass, too badly carbonated for analysis.

Extending a certain distance in from the margin, along the base or just above it, in the E. and NE. parts of the mound, scattered here and there, and not closely associated, were many sherds and numerous vessels of earthenware. These vessels had the mortuary perforation of base almost without exception. In the great majority of cases the vessels were imperfect through breakage before interment and

[1] For the opinion of a veteran field worker see "Archæological History of Ohio," page 588, *et seq.*, by Gerard Fowke, Columbus, Ohio, 1902.

the few vessels found whole, with the exception of the mortuary perforation, of course, were, save one, undecorated and of inferior ware. This exception was a vessel bearing a complicated stamp decoration about 2 inches wide, below the margin (Fig. 168). A number of imperfect vessels and sherds also bore the complicated stamp. One of these is shown in Fig. 169.

Fig. 168.—Vessel of earthenware. Jackson mound. (Half size.)

Fig. 169.—Sherd. Jackson mound. (Half size.)

Three vessels, separate, were found more centrally located in the mound, though not immediately associated with burials, than was the general deposit of earthenware which came to an end before interments were met with. One is an undecorated vessel of about 1 pint capacity, of excellent ware, having the form of a gourd. Part of the handle is broken and missing. Another (Fig. 170), with semi-globular body with incised and punctate decoration, had two necks and two orifices, where similar necks, which have since been restored, had been. The base is imperforate. Maximum diameter of body, 6.3 inches; height, with neck, 6.6 inches.

The third vessel, an undecorated pot of about 1 pint capacity, has a certain amount of bitumen which, melted at one time, has hardened on the base. This glue-pot, of necessity, has no basal perforation. We know bitumen to have been in common use among the aborigines, and Cabeça de Vaca tells how he went to what is now the Alabama frontier and acquired in trade various articles, including cement, which was, doubtless, bitumen.

Also in the E. and NE. parts of the mound and comparatively near the margin, presumably deposited for the dead in general were: a soapstone pipe of the common rectangular block pattern and fourteen hatchets, or "celts", ranging in length

between 2.5 inches and 11.25 inches. Many of these are rudely made though some are carefully smoothed and taper gracefully to a blunt point opposite the cutting edge. Certain of these hatchets lay in pairs.

With the "celts" were two double bladed hatchets, probably of granitoid rock, much weathered, 6 inches and 4.8 inches in length, respectively, showing where a central fastening had held them to a handle.

Fig. 170.—Vessel of earthenware. Jackson mound. (Seven-ninths size.)

Also unassociated there came from the mound hammer-stones, whetstones and hones.

Together were: one pebble rudely chipped to resemble a small hatchet; two

rounded pebbles; two smooth pebbles; a spear-head with broken point; a pebble grooved at one end for a pendant; and a neat little pendant also grooved at one end.

One pebble-hammer, three pebbles, one chert arrowhead or knife lay closely associated, while eight pebbles and pebble-hammers were found together in another place.

A lance-head of chert, 5.2 inches in length, lay in the outer part of the mound among the hatchets.

Two graceful and keen-pointed arrow-or lance-points of chalcedony, lay together.

Also in the mound were: two arrowheads; one small lance-point; a bit of quartz crystal; a pendant of quartz crystal, with the part above the groove broken off; a mass of galena, 2.5 inches by 2 inches, rounded and flattened at the ends as though by use as a hammer.

A fact worthy of note in this mound is that, with the exception of one small pocket of calcined human bones found by us on the Alabama river, that in the Jackson mound is the westernmost example of cremation met with by us.

Mound near Huckleberry Landing, Franklin County.

Jackson river empties into the Apalachicola about 5 miles above the mouth of the river which enters the bay of that name near the town of Apalachicola.

Huckleberry landing is about 2 miles above the junction.

About 100 yards from the landing, on the south side of the river, in hammock land, on property of Mr. David Silva, resident nearby, was a mound which had undergone a certain amount of previous digging, though not sufficient greatly to impair the scientific value of our investigation.

About 100 yards northwest from the mound were a shell-field and numerous aboriginal shell deposits composed mainly of shells of a small clam (*Rangia cuneata*). One of these deposits, from 1 to 3 feet in height, nearly oval in shape, is 120 feet E. and W. and 180 feet N. and S., inside diameter. Other shell deposits lie to the eastward of the mound.

The mound, which was entirely dug through by us, was 5 feet 4 inches in height and had a basal diameter of 38 feet E. and W. and 52 feet N. and S. It was composed of sand with no regular stratification. In places, especially toward the base, were various deposits of a clayey sand exceedingly tough and forming almost a matrix. In this material often were shells of the kind present in the adjacent shell deposits, while other pockets and small layers of these shells were present in the looser sand also.

Burials, of which we found thirty-four, began near the margin on the eastern side and continued at intervals until the body of the mound was reached, where they became more numerous. In other parts of the mound burials were not met with beneath the slope. A few of the burials were near the surface. Some were 4.5 feet down while one was lower still. So often did the bones lie in the tough clayey material, of which we have spoken, that it seemed as though this clayey sand had been put in expressly with the burials. Those that did not were the superficial burials, with one exception, to be referred to later. Upon several occasions burials

of single skulls came from the mound like great balls of clay, the skulls being within the masses.

Eleven burials were of flexed skeletons, some turned to the right, others to the left. The flexion in this mound was much closer in character, as a rule, than was that noted by us in the Jackson mound, though several examples of loose flexion were met with. The heads of the skeletons pointed in all directions. Twelve burials consisted of lone skulls, while the remaining eleven interments were made up of skulls with a few bones; various bones without skulls; several aboriginal disturbances where parts of skeletons had been removed in making place for others; a mass of bones containing three skulls; one burial which fell in caved sand.

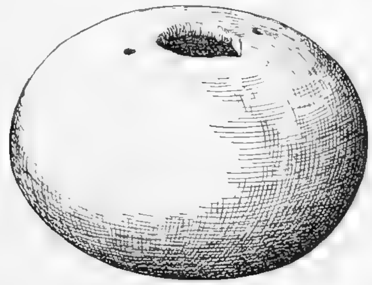


Fig. 171.—Vessel of earthenware. Mound near Huckleberry Landing. (Half size.)

Fig. 172.—Smoking pipe of earthenware. With Burial No. 22. Mound near Huckleberry Landing. (Full size.)

Beneath the center of the base of the mound was a burial included in our list, consisting of a skull, a tibia and a piece of bone belonging to the fore-arm. This burial lay in sand below the level of the clayey deposit and was, perhaps, the initial interment.

Burial No. 1, a flexed skeleton, had marks of serious inflammation, and Burial No. 2, also flexed, showed a similar condition of several bones. This person, the fragmentary condition of whose bones precluded identification as to sex, seemed to have been peculiarly unfortunate as a radius had an ununited fracture whose rough surface with a certain amount of surrounding callous, showed death to have intervened before the parts could unite. This radius was sent to the Army Medical Museum, Washington, D. C.

But few artifacts lay with the bones. With one was a pebble-hammer; with another a pebble.

Burial No. 8, consisting of a skull and two thigh bones, had somewhat above it a rude, undecorated vessel with perforate base. Extending from this vessel in a northerly direction for 2.5 feet was a deposit made of several considerable parts of coarse undecorated vessels of ordinary types and many sherds from various vessels, some undecorated, one with a small check stamp and a number with complicated stamps. On the northernmost sherd, a large one, lay a single skull.

With burial No. 21, one femur and two tibiæ, was an undecorated spheroidal vessel of compact ware, 3.6 inches in diameter and 2.6 inches in height. The circular aperture is but .8 of an inch in diameter. On either side are small perforations for suspension. There is a basal perforation (Fig. 171).

With Burial No. 22, a partial flexion on the right side, was a smoking pipe of earthenware with bowl and portion for the stem, circular in shape and at right angles to each other. Each orifice is about 1 inch in diameter (Fig. 172). This burial was fairly well preserved and, being near the surface, may have been an intrusive one.

With Burial No. 23, bones disturbed by caving sand, was a pear-shaped "sinker" or pendant, wrought from a quartzose pebble, with the smaller end grooved for suspension.

Burial No. 26, a skeleton flexed on the left side, lay 4 feet 7 inches down, a few feet from the center of the mound. At either side of the head, was a disc of sheet copper about 2.7 inches in diameter having a central incused space with a small perforation in the middle, surrounded by a *repoussé* margin. Behind each disc, that is between the disc and the skull, was a disc of earthenware about 1.7 inches in diameter, having a small central perforation. On the outside of one of the copper discs there remains a knot formed from a cord or a sinew. It is evident, then, that these objects were ear-plugs, the copper being worn on the outside of the ear while the earthenware disc, fastened to the copper one, remained at the back of the lobe of the ear.[1] We are unable to say whether or not the two discs comprising each ear-plug were permanently fastened and the smaller disc buttoned through a hole in the lobe of the ear. Very likely this was the case since we know the custom among the aborigines to have a great opening in the lobe of the ear, obtained from Peru northward.

Burials Nos. 29 and 30 had each a turtle-shell in association. These shells, each about 7 inches across, if used for rattles, must have contained perishable material as no pebbles were met with inside.

Burial No. 31 had near it an undecorated vessel of poor material and ordinary type, having the usual basal perforation.

In this mound were no deposits distinctly marginal, as objects put in for the dead in general were found in all parts of the mound and at all depths.

[1] We found two earthenware discs of this kind and fragments of sheet copper, in a low mound near Helena, Lake Co., Fla., and described them in our "Certain Sand Mounds of the Ocklawaha River, Florida," Journ. Acad. Nat. Sci., Phila., Vol. X, but did not know their use at that time.

Many sherds found singly and probably of accidental introduction were present, as were numbers of others in close association, probably substitutional offerings. Some were undecorated, two or three bore the small check stamp, while many had the complicated stamp decoration. Three of these are shown in Figs. 173, 174, 175. Incised decoration was practically unrepresented.

FIG. 173.—Sherd. Mound near Huckleberry Landing. (Half size.)

FIG. 174.—Sherd. Mound near Huckleberry Landing. (Half size.)

Seven vessels lay unassociated with burials. Five are undecorated; one, somewhat imperfect, has a complicated stamp and is of material superior to the rest. Five have basal perforations. Five are of ordinary type as to form.

Vessel No. 6, shown in Fig. 176, is undecorated, imperforate, circular in transverse outline.

FIG. 175.—Sherd. Mound near Huckleberry Landing. (Half size.)

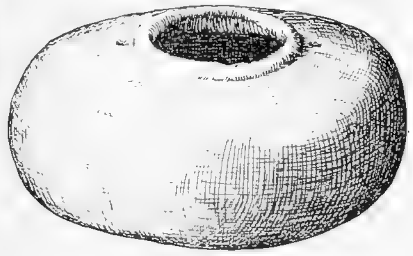


FIG. 176.—Vessel No. 6. Mound near Huckleberry Landing. (Half size.)

FIG. 177.—Knife of chert. Mound near Huckleberry Landing. (Full size.)

Vessel No. 7, an urn with slightly scalloped margin of which parts are missing, has a complicated stamp decoration. The base is perforated.

Vessel No. 10, a small pot, undecorated, has four feet.

Rudimentary feet are on the bottom of part of a small vessel found unassociated in the sand and two feet are on half a vessel broken longitudinally.

A smoking pipe of earthenware of the "Monitor" type lay unassociated. Part of the mouth-piece which presumably was as long as the projection on the opposite side of the bowl, is missing through an early fracture. Present length, 4.25 inches; height, 2 inches; diameter of bowl, .7 of an inch.

Throughout the mound were numbers of pebble-hammers, hammer-stones, pebbles and several broken hones. In one instance twenty pebbles and pebble-hammers lay together. There were present also many small masses of chert, possibly "wasters."

Four hatchets, or "celts" lay unassociated.

A sheet of mica lay just below the surface.

With seven pebbles and pebble-hammers was a large flake of chert, probably used as a knife.

Loose in the sand, was a knife of chert, perhaps formerly an arrowhead from which a considerable part had broken longitudinally, involving the margin of the shank. The broken side has been carefully chipped to remove the thick surface left by the fracture (Fig. 177).

Mound near Porter's Bar, Franklin County.

This mound, in thick scrub, is on property of Mr. T. J. Branch, living on the place, situated one mile west of Green Point and a short distance from Porter's Bar.

The mound, which had sustained but little previous digging, had deep depressions in places around it whence the sand used in its building came. Its outline was somewhat irregular, it being much steeper toward the east where it bordered a brook than on the west where it sloped to the level of the surrounding country. Its basal diameters were 60 feet and 78 feet; its height was between 10 feet and 11 feet. It was totally dug down by us.

The mound was composed of irregular strata and masses of sand, sometimes white, sometimes yellow, and in places blackened with organic matter. This black sand was particularly noticeable in the eastern part of the mound from the margin in as long as the principal deposit of pottery was met with.

Beginning at that part of the margin of the mound included between W. and NW. and extending shortly after to SW. was a layer of oyster shells, of irregular thickness, on the base of the mound. This layer, from 1 foot to 2.5 feet in thickness, covering about one-quarter of the area of the mound, was purposely made and not a shell-heap antedating the building of the mound. There were also two or three local pockets of shell, each about 3 feet square and having the same thickness as the principal layer.

Human remains lay in all parts of the mound, which was contrary to our usual

experience and, as a rule, were on or near the base, though some were higher in the mound. A certain number lay below the shell layer, while others were just above it. Scattered bones lay here and there among the shells. Superficial burials, after the mound had reached a considerable height, were not present.

There were noted by us in the mound sixty-eight burials, including the closely flexed, the loosely flexed, the bunch, the lone skull, scattered bones, one burial in a

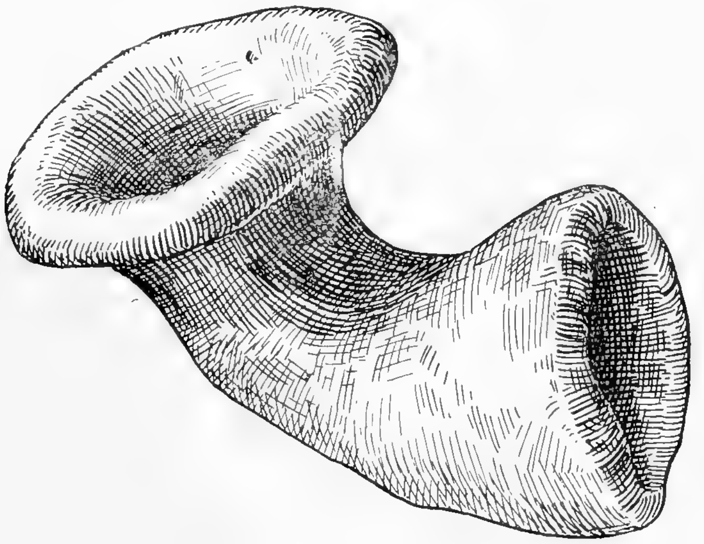


FIG. 178.—Smoking pipe with Burial No. 60. Mound near Porter's Bar. (Full size.)

squatting position and one pocket of calcined fragments of human bones, which resembled the deposits of cremated bones in Georgia where many fragments, all calcined, lie together. Cabeça de Vaca tells[1] us "it is their custom to bury the dead unless it be those among them who have been physicians, and those they burn."

Though the state of the burials was such through decay and pressure of sand that no skulls were preserved, yet a number, though fragmentary, permitted examination as to cranial compression. In but one case was compression noted and then to a moderate degree only.

Burial No. 23 consisted of badly decayed bones in a shallow grave below the base. With them was a rude lancehead.

Burial No. 27, a skull and some badly decayed bones had sand colored with hematite in association, as did a number of other burials in the mound.

Burial No. 49 had teeth alone remaining. With these were a small earthenware vessel and a smoothing stone.

Burial No. 50, a lone skull, had with it a hammer-stone, a small stone pendant, a bit of sandstone, a pebble-hammer and three cutting implements made from columellæ of large marine univalves.

Burial No. 54, a lone skull, had in association a small earthenware vessel (No.

[1] The Narrative of Alvar Nuñez Cabeça de Vaca, translated by Buckingham Smith. Washington, 1851, pg. 49.

87) intact as to the base, which was the case with several pots and bowls, all diminutive, found directly with burials in this mound.

Burial No. 59 was a skeleton in a squatting position on the base. With it were: a pendant of shell; an arrowhead or knife, of jasper; a small undecorated clay smoking pipe; clam shells; six pendants,[1] one bottle-shaped and grooved, made from a quartz pebble, five of ordinary types, one of these of red indurated shale and four of igneous rock.

Burial No. 60, a flexed skeleton, had with it an undecorated smoking pipe of clay with comparatively small bowl and flaring rim (Fig. 178).

Burial No. 63, bones disturbed by caving sand, had nearby five implements, some for cutting, some for piercing, made from columellæ of large marine univalves; three shell gouges, one without a cutting edge; a bit of sandstone and a pebble-hammer.

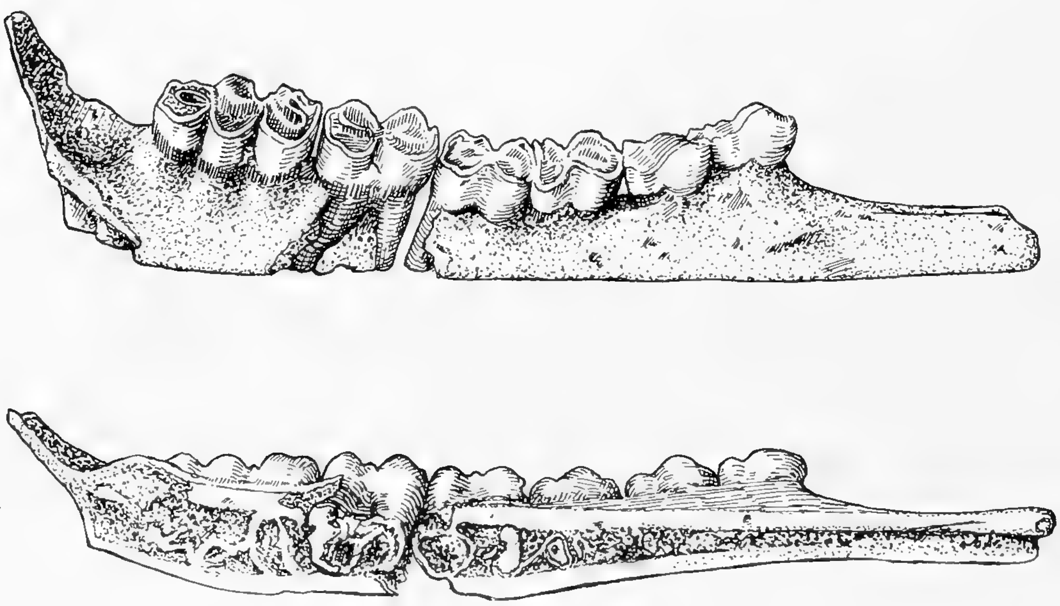


Fig. 179.—Part of deer jaw cut off at base. Two positions. Mound near Porter's Bar. (Full size.)

Burial No. 64, a partly flexed skeleton, lay on the base of the mound. With it were: a small chisel, probably of volcanic rock, somewhat broken; a triangular hammer-stone, rudely grooved for a handle; and four shell gouges.

With other burials were: two "celts;" the small vessels of which we have spoken; and a number of hammer-stones, smoothing-stones and shell drinking cups.

Apart from burials were: three "celts;" a flake of chert, probably a knife; several arrow and lanceheads, some of chert, some of quartzite; mica; shell drinking cups; a lump of galena, of considerable size, apparently having seen service as a hammer; a pendant, probably of ingenous rock; a number of shell implements badly

[1] As to the uses made of plummets, see "Archæological History of Ohio." Fowke, pg. 556, *et seq.*

decayed as a rule; bitumen, in one instance; plumbago; and the quota of hones, hammer-stones, smoothing-stones, pebble-hammers, usually present in mounds.

With a number of artifacts fallen in caved sand and probably at one time associated with a burial, were three jaws of small rodents, also two parts of a lower jaw of a deer, with the base cut away to leave a flat surface (Fig. 179).

We three times found jaws of large carnivores treated this way, in mounds of the Georgia coast and suggested in our report[1] that they had been thus treated to facilitate insertion into wooden masks.

Mr. Cushing at Marco found "certain split bear and wolf jaws neatly cut off"[2] so as to leave the canines and two bicuspids standing. On the jaws were traces of cement. Mr. Cushing believed these jaws to have been let into war-clubs, which may well have been the case with teeth of large carnivores, but hardly so where jaws of deer were used.

Mr. Moorehead found in Ohio mounds human jaws treated in the way we have described, some with perforations in addition, and regards them as ornaments.[3]

From all this, the reader has doubtless come to the conclusion, and rightly, that the use made of these curiously treated jaws is still an open question.

A feature often noticed in the mounds, namely the tendency to place with the dead objects no longer of use to the living, was illustrated in this mound by the finding with a burial, of eight arrow- and lance-points, five of chert, three of quartzite. Of these, five wanted either a shank or a barb; of the remaining three, two were in the rough.

In caved sand was part of an ornament of sheet copper.

Broken into several parts by palmetto roots which had penetrated it, was a curious object of impure kaolin,[4] almost cylindrical, with a certain rounded enlargement at either end. This object, which is 11 inches long and has a middle diameter of 2.5 inches and of 3 inches at either end, had been carefully smoothed at one time and still, in places, shows traces of decoration in low relief. A similar object, found in a much better state of preservation, will be figured and described in our account of Mound B, Warrior river.

Including with whole vessels those which were broken but had full complement of parts, and others from which but small parts were missing, ninety vessels came from this mound. The ware was most inferior, as a rule; the decoration poor in design and rudely executed. Undecorated vessels predominated and, as a rule, when decoration had been attempted, it consisted of the complicated stamp, usually rudely and irregularly applied. The use of this form of decoration, even when carefully executed, is always unfortunate in a mound, since it is likely to take the place of incised design which calls for greater originality. Farthermore, many of the vessels with complicated stamp were not covered as to the entire body, but had only a

[1] "Certain Aboriginal Mounds of the Georgia Coast," pp. 65, 88, 112. Journ. Acad. Nat. Sci. Phila. Vol. XI.

[2] Proc. Am. Philosoph. Soc. Vol. XXXV, No. 153, pg. 45. Phila., 1897.

[3] "Primitive Man in Ohio," pg. 226, *et seq.*

[4] Kaolin is found in Florida.

comparatively narrow band of the decoration on or below the neck. This form sufficiently ornamental when carefully done, is much less so when the stamp is irregularly and faintly applied.

FIG 180.—Vessel No. 9. Mound near Porter's Bar. (Full size.)

Although a number of sherds and several vessels were found in the southwestern margin of the mound at the very start, yet the great majority of the vessels lay in the eastern portion and were included within the first fifteen feet of the slope. With these were the usual sherds. Farther in, in the same direction, were certain other vessels extending along the base like the rest, but with these were no piles of

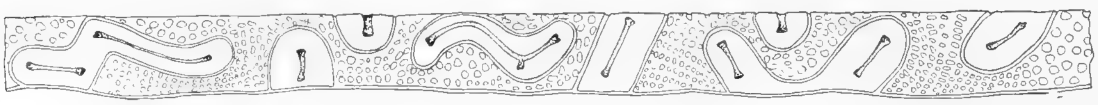


FIG. 182.—Vessel No. 9. Decoration. Mound near Porter's Bar. (Half size.)

sherds such as marked the deposit of ware in the outer portion of the mound. There was no central deposit.

We shall now describe the most noteworthy of the vessels. Unless otherwise stated, the usual basal perforation is present, all without it being included in our list.

Vessel No. 4.—Has a decoration of vertical parallel lines, rudely executed.

Vessel No. 9.—A bowl of excellent ware, of about 1 quart capacity, colored crimson inside and out (Fig. 180), with incised and punctate decoration in which appears the symbol of the bird, shown in diagram (Fig. 181).

Vessel No. 10.—A toy vessel with globular body and flaring quadrilateral neck.

Vessel No. 11.—Is of eccentric shape as shown in Fig. 182. Unfortunately, a part of the neck is missing from an early fracture.

FIG. 182.—Vessel No. 11. Mound near Porter's Bar. (Half size.)

Vessel No. 15.—An undecorated imperforate cup.

Vessel No. 18.—Has a hemispherical body and slightly flaring neck (Fig. 183), around which is an incised and punctate decoration shown in (Fig. 184) in which the punctate markings have been accidentally omitted from the rectangular space in the right upper portion.

Vessel No. 21.—A curious wedge-shaped vessel, a form new to our mound work. The decoration, incised, is practically the same on either side (Figs. 185, 186). Height, 8.5 inches; maximum diameter, 4.8 inches.

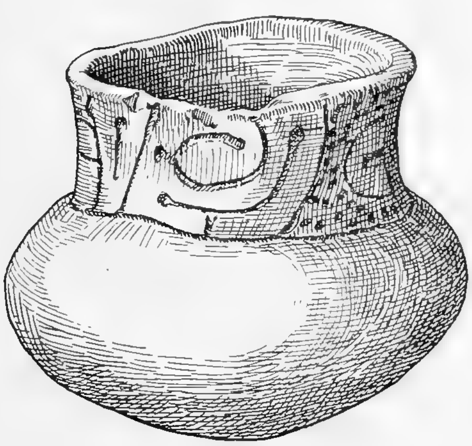


FIG. 183.—Vessel No. 18. Mound near Porter's Bar. (Two-thirds size.)

Vessel No. 29.—A little bowl of inferior ware, having below the rim a band about 1.5 inches in breadth, made up of series of rudely incised perpendicular lines, of diagonal lines and of horizontal lines.

Vessel No. 30.—This vessel, undecorated save for a single encircling incised line a short distance below the rim, consists of an upper part somewhat elliptical in horizontal section, placed upon a flattened sphere (Fig. 187).

Vessel No. 33.—This handsome trilateral vessel (Fig. 188), unfortunately found broken into many pieces, probably represents some quadruped in incised and punc-

tate decoration as conventionalized fore-legs and hind-legs are clearly shown (Fig. 189). An animal head is probably missing from the rim in front.

Vessel No. 35.—A bowl of about one-half pint capacity, with incised decoration on one part only, shown diagrammatically in Fig. 190.

Vessel No. 36.—Portions of a compartment vessel, scattered throughout the mound. Parts are missing.

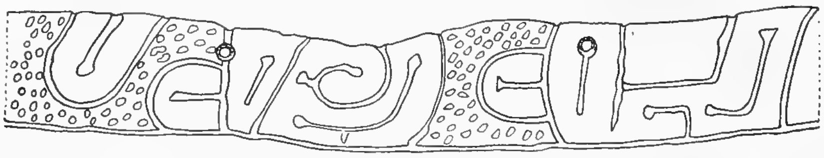


FIG. 184.—Vessel No. 18. Decoration. Mound near Porter's Bar. (Half size.)

Vessel No. 60.—An imperforate pot.

Vessel No. 61.—A water-bottle with a most interesting incised design representing some highly conventionalized form. In addition to the "killing" in the base, a small hole has been knocked in the side of the vessel, involving the decoration to a very limited extent. Diagram (Fig. 191) shows the design with slight restoration.

FIG. 185.—Vessel No. 21. Mound near Porter's Bar. (Half size.)

FIG. 186.—Vessel No. 21. Another view. Mound near Porter's Bar. (Half size.)

FIG. 187.—Vessel No. 30. Mound near Porter's Bar. (Half size.)

FIG. 188.—Vessel No. 33. Mound near Porter's Bar. (Eight-ninths size.)

Vessel No. 63.—The piece knocked from the bottom of this pot was found lying within it, as was the case with another vessel in this mound.

Vessel No. 66.—A bowl of about 1 pint capacity, of red ware, with a handle in the form of a rather rude owl-head looking inward, which, with the exception of crimson paint, inside and out, is the only decoration.

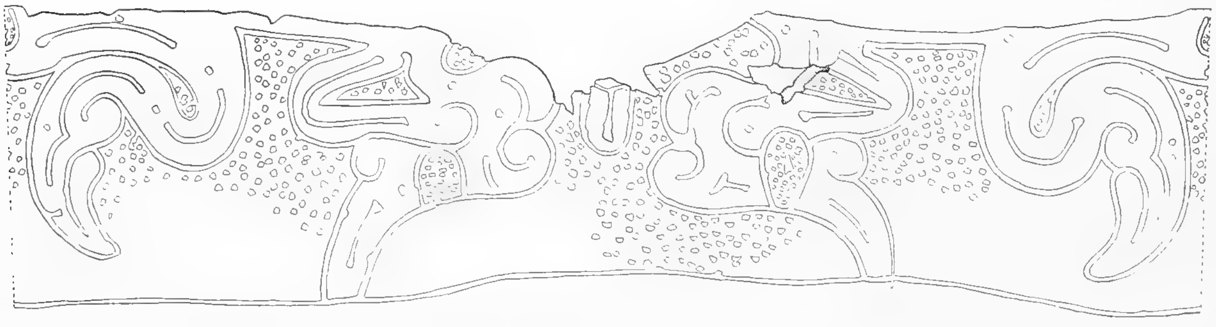


Fig. 189.—Vessel No. 33. Decoration. Mound near Porter's Bar. (One-third size.)

Vessel No. 69.—An imperforate pot with a rough complicated stamp around the neck.

Vessel No. 71.—A graceful undecorated vessel, ovoid in shape, with holes below the rim, for suspension (Fig. 192).

Vessel No. 74.—A shallow bowl 5 inches in diameter, to which a part, missing when found, has been added. There has been incised and punctate decoration over the base, part of which is wanting. A conventionalized animal paw, however, still

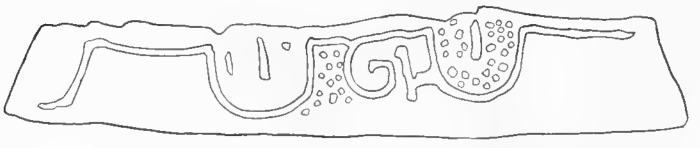


Fig. 190.—Vessel No. 35. Decoration. Mound near Porter's Bar. (Half size.)

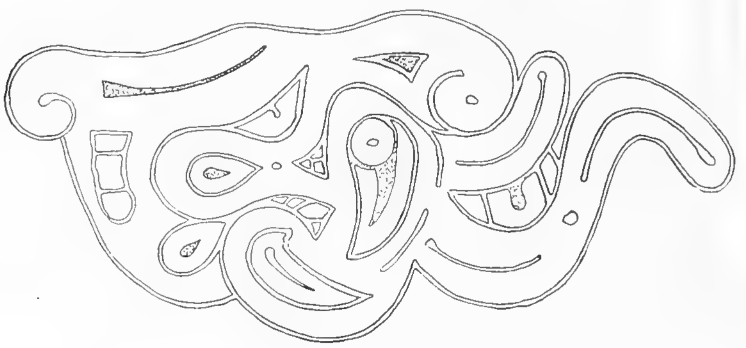


Fig. 191.—Vessel No. 61. Decoration. Mound near Porter's Bar. (Half size.)

Fig. 192.—Vessel No. 71. Mound near Porter's Bar. (Half size.)

remains. The head of an aboriginal dog is represented as looking inward from the rim (Fig. 193). Cabeça de Vaca and the chroniclers of De Soto refer to aboriginal dogs in Florida. Skeletons from the mounds show these dogs to have resembled collies, with somewhat broader jaws.

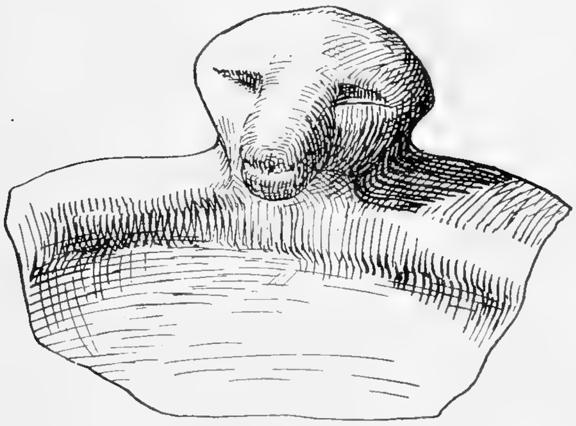


FIG. 193.—Vessel No. 74. Mound near Porter's Bar. (Full size.)

Vessel No. 75.—A life-form from which the head and part of the tail unfortunately are missing, is shown in Fig. 194. The decoration, similar on either side, represents fur and conventionalized fore-legs and hind-legs. Judging from the flat tail, possibly the representation of a beaver is intended.

Vessel No. 78.—A little bowl, lenticular in shape, of less than one pint capacity, imperforate, lay with a burial. The decoration consists of two incised designs shown in diagram in Fig. 195. With this vessel was the astragalus of a deer. Such knuckle-bones were used in games.[1]

FIG. 194.—Vessel No. 75. Mound near Porter's Bar. (Half size.)

Vessel No. 82.—A vessel, somewhat globular in shape, of about 1 gallon capacity, having a complicated stamp decoration around the upper part (Fig. 196).

Vessel No. 87.—Imperforate, of red ware, of somewhat less than one-half pint

[1] For details, see "Chess and Playing Cards," by Stewart Culin, pg. 826, *et seq.* Report U. S. National Museum for 1896.

capacity. From the center of the base a small knob protrudes. There are holes for suspension (Fig. 197).

Vessel No. 88.—A small vessel intact as to the base, with perforations for suspension (Fig. 198).

Vessel No. 89.—A vessel of about 1 pint capacity, elliptical in longitudinal section, the major sides incurving toward the margin. There are holes on the same side for purpose of attachment. The only attempt at decoration is on the side shown in Fig. 199. The part to the left is very suggestive of an effort to portray a quadruped whose fore-legs are in line and also the hind-legs. The head and tail are shown. The figure to the right may represent a bird.

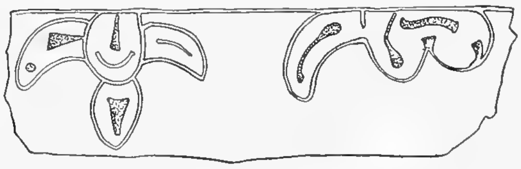


Fig. 195.—Vessel No. 78. Decoration. Mound near Porter's Bar. (Half size.)

Fig. 196.—Vessel No. 82. Mound near Porter's Bar. (Two-fifths size.)

Fig. 197.—Vessel No. 87. Mound near Porter's Bar. (Full size.)

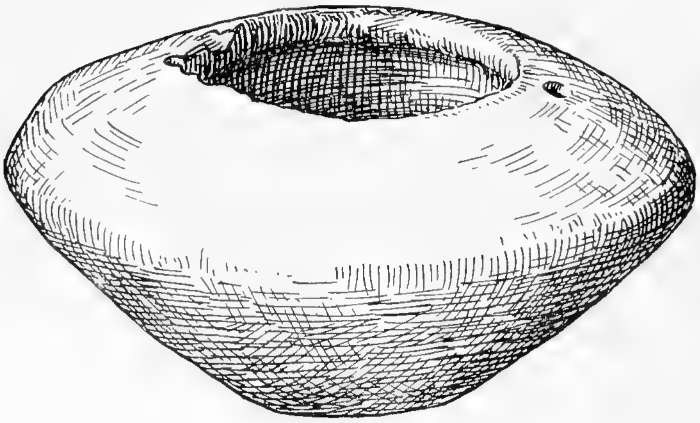


Fig. 198.—Vessel No. 88. Mound near Porter's Bar. (Full size.)

Fig. 199.—Vessel No. 89. Mound near Porter's Bar. (Half size.)

Vessel No. 90.—A compartment vessel consisting of a long division with a a smaller one on either side. A part broken from one end has been filled in (Fig. 200).

FIG. 200.—Vessel No. 90. Mound near Porter's Bar. (Three-fourths size.)

Certain pieces of an effigy-bottle representing the human form, with the head unfortunately absent, were recovered from the mound. The arms and the hands are in relief. Each finger is distinctly shown.

The check stamp was present in the mound but once and, as it lay among the shell, it was probably introduced with it.

Figs. 201, 202, 203, show three sherds with complicated stamp from this mound.

Mound near Green Point, Franklin County.

This mound, also on property of Mr. T. J. Branch, was in a field formerly cultivated, a short distance in a SW. direction from the mound just described. There was no sign of previous digging, but members of the family informed us that during cultivation certain relics had been laid bare by the plough. The height of the mound was 2 feet, though on the western side it was necessary to go down 5 feet to reach undisturbed sand. The basal diameter was 62 feet. The mound was completely dug through.

It was composed of sand, light in color as a rule, but blackened with organic

matter in certain places. There were many small deposits of oyster-shells here and there throughout the mound, and scattered shells lay in the sand. In two or three cases oyster-shells lay with burials, but as there were so many cases where they did

FIG. 201.—Sherd. Mound near Porter's Bar. (Half size.)

FIG. 202.—Sherd. Mound near Porters Bar. (Three-fourths size.)

FIG. 203.—Sherd. Mound near Porter's Bar. (Three-fourths size.)

not and as local deposits of shell were so numerous, it is entirely possible that the proximity of the shells to the burials was accidental. Burials were in all parts of the mound but were especially numerous in the central portions.

There were in all eighty burials, as a rule closely flexed skeletons, though loosely flexed skeletons, lone skulls, bunches of bones and scattered bones were met with. No flattening was noticed in the case of any skull whose condition was such as to allow determination.

With burials in different parts of the mound were single vessels of earthenware; also a deposit of thirteen beneath a skeleton in the western part of the mound and a deposit of three vessels, near human remains, a little east of the center.

There were also in the mound, hones, hammer-stones, smoothing-stones, pebble-hammers and kindred objects which it is hardly necessary to describe in detail.

With one burial, among other things, were two rounded ends of "celts" which had no doubt been put in substitutionally, a part for the whole, a most economical method and one widely practised by the aborigines, as we have seen.

There were present also a number of lanceheads and projectile points, all but one or two of which were more or less broken or unfinished. Three "celts" lay with burials. Two of these had the cutting edge so badly chipped that prolonged grinding would have been necessary before use.

Forty-four water-worn pebbles, slingstones no doubt, lay together, and a number of burials had with them shell drinking cups mostly having the basal perforation. Some of these cups were carefully wrought, the whole beak of the shell being ground away, giving the shell a graceful and cup-like appearance.

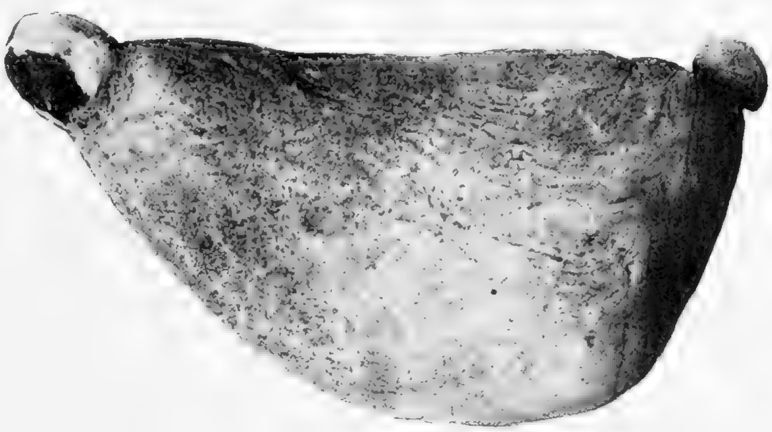


FIG. 204.—Pendant of shell. Mound near Green Point. (Full size.)

Between two burials were: a number of decayed mussel-shells; bits of sandstone; unfinished shell gouges; a rude cutting implement of chert; a bone of a small mammal; fragments of shell; two rectangular pieces of fossilized wood; a number of collumellæ of large marine univalves; sections of columellæ carefully rounded as though for large beads in block; sandstone hones; fragments of various rocks, mostly chert; a small triangular piece of sandstone sharpened as for piercing; a barbed arrowpoint; a small marine shell; an object resembling in shape the tine of a stag horn, a recent formation containing small marine shells; two discs of shell, each about 3.5 inches in diameter, evidently the first stage in the making of gorgets;

two shell discs much smaller; a diamond-shaped section of the body whorl of a large univalve; a pendant made from a marine columella, 5.5 inches in length; a small gouge of shell; a heavy ornament of shell with two ends grooved for suspension (Fig. 204), 4 inches long and 2 inches thick. With these objects were many bits of stone and of shell of no particular interest.

Another mortuary deposit consisted of: bits of shell; a large columella worked to a point; another, unworked; one carefully ground to a cutting edge, which, however, is badly chipped; a bit of volcanic rock, a part of an implement; a chipped pebble; three bits of sandstone; a small mass of hardened clay, seemingly; a small part of a "celt"; three sections of a columella, probably beads in block; a rectangular piece of rock, 7 inches long; parts of two under-jaws of small rodents; a pendant of shell of ordinary demijohn form; a pendant of clam-shell, roughly triangular in shape, grooved at one end for suspension; five triangular gouges with rounded lower corners made from the body whorl of *Fulgur;* forty-three similar implements with undressed sides and unground edges, the first step in the making of a gouge, the nature of this latter deposit showing the aboriginal mind to be fully alive to the fact that the departed would have ample leisure in the life to come.

Fig. 205.—Sherd. Mound near Green Point. (Half size.)

Fig. 206.—Sherd. Mound near Green Point. (Three-fourths size.)

Contrary to our usual experience, a general deposit of vessels was found on the western side of this mound and another large deposit farther in on the same side, while no other vessels were met with, except immediately with the dead, and these were well in toward the center.

The earthenware of this mound, on an average, was distinctly inferior to any we had met with so far on the coast. The vessels, when decorated, bore, as a rule, the complicated stamp, often faintly and irregularly impressed. In Figs. 205, 206,

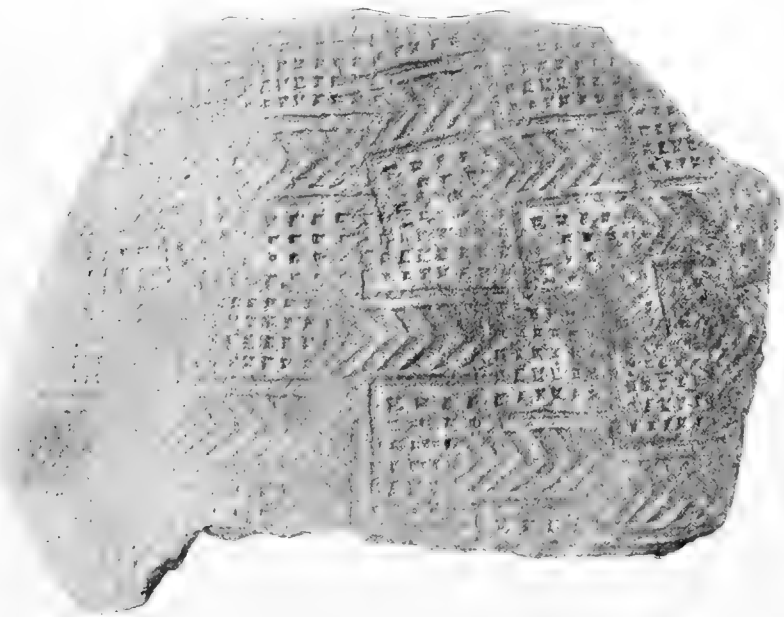


FIG. 207.—Sherd. Mound near Green Point. (Half size.)

207, 208, are shown four fragments of vessels more clearly stamped than the average and with designs new to us.

Incised decoration was met with but three times, on two sherds and on a vessel.

A feature of the mound was the presence of four feet on a considerable percentage of the vessels and scalloped margins on a large number. Curiously enough, neither of these characteristics was especially noted in the neighboring mound. In all, about forty vessels were met with, nearly all of which were in pieces or fell apart upon removal. Of the deposit of thirteen vessels of which we have spoken, but one was taken out entire. It was apparent that the commonest kitchen ware had been placed with the dead.

FIG. 208.—Sherd. Mound near Green Point. (Half size.)

We give in detail a description of the more interesting among the vessels. All are perforated as to the base unless otherwise described.

FIG. 209.—Vessel No. 9. Mound near Green Point. (Nine-elevenths size.)

Vessel No. 1.—A globular bowl with faint complicated stamp and notches on the rim, small and near together, presenting almost a serrated appearance.

Vessel No. 2.—A pot with scalloped rim, having four rudimentary feet. The basal perforation is made carefully to one side of the feet, a practice to which the aborigines were not given, as a rule, in this mound, as a number of bases with feet upon them, which had been knocked from vessels, were found scattered through the mound.

Vessel No. 3.—Undecorated, of eccentric form. The lowest part is almost cylindrical but expands somewhat from the base which is flat. The upper part has been hemispherical, probably. A part of it is missing.

Vessel No. 4.—An oval jar of about 3 gallons capacity, with scalloped rim and zigzag complicated stamp.

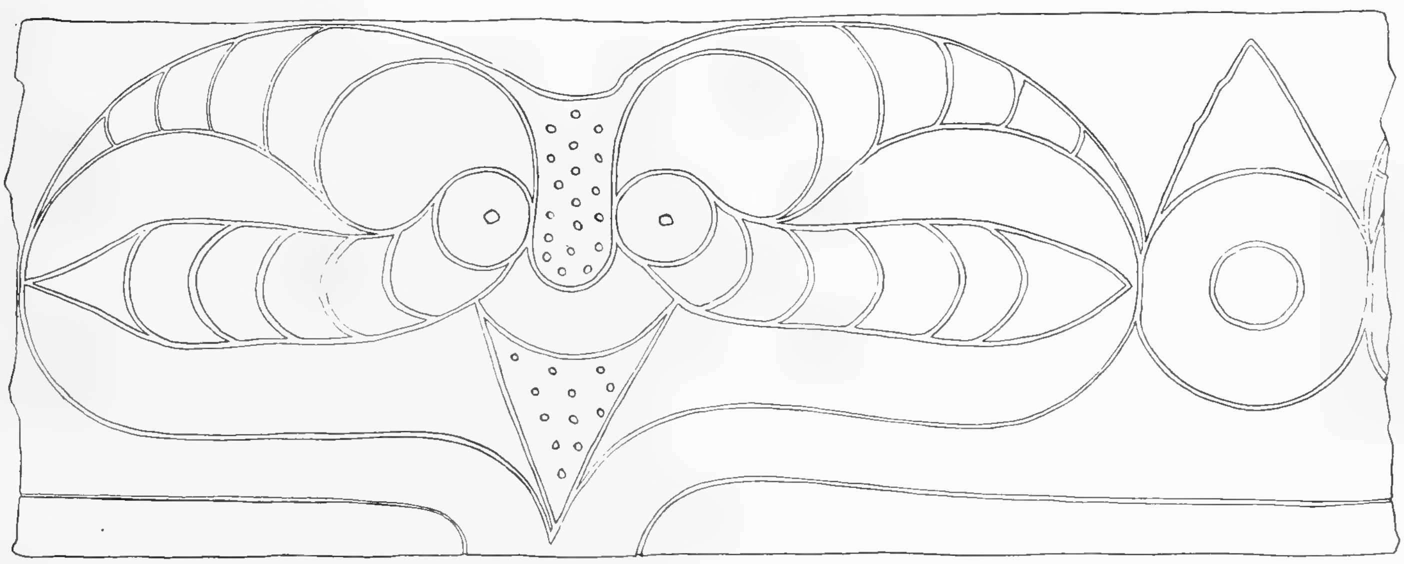


FIG. 210.—Vessel No. 9. Decoration. Mound near Green Point. (Half size.)

Vessel No. 5.—A pot of about 5 gallons capacity, with scalloped rim and complicated stamp decoration. It fell into bits upon removal. With it was a knucklebone of a deer. A similar bone lay with another vessel in this mound.

Vessel No. 6.—A large vessel found in pieces. The decoration was seemingly the impression of basket-work.

Vessel No. 7.—Small, imperforate, undecorated, with flaring rim and four rudimentary feet.

Vessel No. 9.—This vessel (Fig. 209), consists of an undecorated cylinder supporting a much flattened sphere, from which is a flaring neck with scalloped margin. The decoration, which is incised and painted, consists of two similar designs, one of which is shown in diagram (Fig. 210). Height, 8.8 inches; maximum diameter of body, 8.7 inches.

Vessel No. 10.—A vase of inferior ware, of about 1 quart capacity, with ovoid body, flaring neck and scalloped rim, undecorated (Fig. 211).

Vessel No. 12.—A frail vessel of about 1 pint capacity, elliptical in horizontal section, with rim slightly flaring, having on one side an impression resembling the foot of a bird. On the opposite side the circular portion of the foot is given without the claws (Fig. 212).

FIG. 211.—Vessel No. 10. Mound near Green Point. (One-third size.)

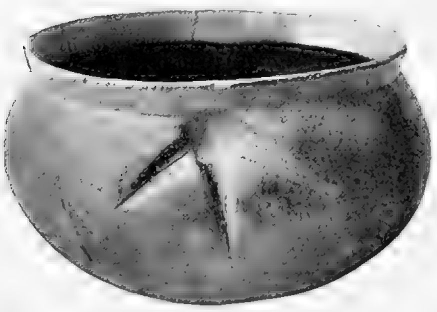


FIG. 212.—Vessel No. 12. Mound near Green Point. (Half size.)

Part of an earthenware smoking pipe lay unassociated in the sand.

From caved sand came part of a smoking pipe of the "platform," or "Monitor," type. A part of one end has been broken off and the endeavor to cut off the rough projecting portion to leave an even surface to join the two parts has been begun but not completed.

In addition to the customary perforation extending through one end of the platform to the bowl, there is another running from the base of the bowl to the base of the platform below (Fig. 213). We wrote to Mr. Warren K. Moorehead as to this curious feature, who most obligingly addressed twelve prominent collectors of this country and forwarded the replies to us.

Smoking pipes with holes accidentally made by the slipping of drills are well known, as are some instances of this carefully made basal perforation. Mr. H. P. Hamilton, of Two Rivers, Wis., kindly forwarded for our inspection two smoking pipes, one showing the accidental perforation, the other the intentional one in the base.

General Gates P. Thruston suggests that this hole in pipes was made to facilitate the cleaning of the bowl and that the hole was plugged during smoking. This seems a probable solution of the question. We are unable to say whether this pipe is stone or earthenware thoroughly baked, and experts, consulted on the subject, have not been able to decide without mutilating the specimen.

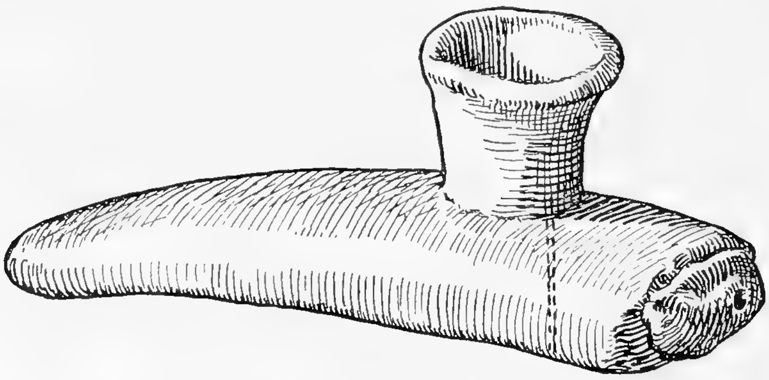


FIG 213.—Smoking pipe. Mound near Green Point. (Full size.)

Mound near Carrabelle, Franklin County.

Within sight of the water, on the right hand side going down the Carrabelle river, about 1.5 miles by land in NW. direction from Carrabelle, is a mound 45 feet across and about 1.5 feet high, which had been much dug into before our visit. On the surface were small fragments of human bones. Considerable trenching yielded nothing of interest.

Tucker Mound, Franklin County.

In sight of the water, which was about 200 yards distant, about one mile from the lower end of Alligator Harbor, on the north side, on property, the ownership of which is uncertain, was a mound about 80 feet in diameter N. and S. and 86 feet E. and W. The slope on the eastern side was much more gentle than elsewhere, forming a graded way. The height of the mound from the general level on the west side was 8.5 feet. A measurement taken near the center, from the surface to the base, showed 9.5 feet.

At various points around the mound were excavations whence the sand came for the building. The mound was entirely demolished by us.

The discovery of burials began at the very margin and continued in, being strictly confined to the eastern and southern sides included between the compass points NE. and SW. In the other parts of the mound were neither burials nor artifacts, with the exception of one undecorated vessel partly broken, probably an accidental introduction. Here we have a striking example of the great quantity of sand piled in certain mounds simply to round out a part used for interments.

Burials, which were mainly in the eastern part of the mound, decreased in number as the digging continued and disappeared entirely 9 feet from the center. Especial care was taken by us as to method and position of interments, since this mound, which was of considerable size, was almost intact at our coming, having in it but two or three holes and these were less than one yard in each of their three dimensions.

Seventy-nine burials were noted by us, including the flexed; the bunched, which sometimes had several skulls; the lone skull; and scattering bones.

Many skulls were past determination as to flattening. The majority of those whose condition permitted a decision distinctly showed flattening but certain others just as distinctly did not.

Burial No. 2, consisting of two decayed fragments of bone, had with it two barrel-shaped beads of galena (lead sulphide) each about .9 of an inch in length and .85 of an inch in maximum diameter. Though cubes of galena are often present in mounds as are masses of the material showing use as hammers, we have but once before, to our recollection, met with an ornament of galena, namely, a bead in the great mound at Mt. Royal, Putnam Co., Fla. With the two beads was a "celt." Incidentally, we may say seven of these implements came from the Tucker mound, all directly with burials except two in whose neighborhood, possibly, bones had disappeared through decay. All these "celts" but one were in marginal parts of the

mound, though on or near the base with the original burials, the one exception being under the slope and no wise near the center.

Burial No. 6.—Fragments of bones with which were many conch-shells, not drinking cups, simply the shells (*Fulgur perversum*).

Burial No. 22.—Three skulls with a bit of tibia. With these were a number of large clam-shells and parts of clam-shells showing wear, which probably had been used as tools for cutting and scraping.

With a number of burials in this mound were similar implements of clam-shell.

Burial No. 26.—A closely flexed skeleton lying at the bottom of a grave at the base of the mound which at this point was 5 feet in height. Above the skeleton, which was one of those having a "celt" in association, were 2.5 feet of yellow sand totally differing in color from the gray sand of that part of the mound where the grave was. It would seem as though this grave had been made and filled with sand of another color in a part of the mound but 2.5 feet in height when the grave was made and that later, an additional 2.5 feet had been added to the mound.

Burial No. 28.—A lone skull with charcoal nearby.

Burial No. 30.—A lone skull with a few small shell beads.

Burial No. 33.—A flexed skeleton with two perforated shell drinking cups. A number of such cups were found in the mound but as a rule lying with deposits of earthenware, unassociated with burials.

Burial No. 36.—A lone skull had shell beads and a rude implement of chert.

Burial No. 48.—A flexed skeleton had oyster-shells above it as did Burial No. 57, a flexed skeleton in a shallow grave. These two burials were exceptional in this respect in this mound.

Unassociated with bones were: two small masses of galena; a stone chisel, somewhat broken; mica.

In caved sand was a small fragment of thin sheet copper bearing small *repoussé* designs.

Although there was no marginal deposit of earthenware vessels in the mound, yet the aboriginal custom to place pottery for the dead in general in the eastern portion of mounds, obtained also in this one. Though a number of sherds were found at the start, no vessel was met with until the digging had reached a point 26 feet ESE. from the center where lay together a number of interesting vessels. The deposit of ware continued in between NE. by N. and SE. by S., sometimes single vessels, sometimes a number together. There was no deposit at the center, the last vessel found being 8 feet from it, and but few were met with for some feet farther back.

The vessels, sixty-two in all, whole, nearly so or in a condition to permit reconstruction, all show the basal perforation. As a rule, the ware was inferior and decoration, when present, was usually the complicated stamp, often carelessly applied.

The feature of the mound in respect to earthenware was the presence of many flat bases, even on pots and bowls, where the bases are usually rounded. As usual, numbers of fragments of parts of vessels and whole vessels, crushed together in inextricable masses, lay with whole vessels or with those broken but keeping their form until removed.

We give a detailed description of the most interesting ware.

Vessel No. 1.—This boat-shaped vessel, of about 1 quart capacity, parts of which were found some distance from each other, has since been cemented together, with a certain amount of restoration. At either end is the head of a duck in relief (Fig. 214).

Vessel No. 2.—This interesting bird-effigy, entire, save for a small basal perforation, has incised decoration on the wings and back, the well-known bird symbol. The aperture is at the base of the neck (Fig. 215). Height, 8 inches; breadth, 5.5 inches.

FIG. 214.—Vessel No. 1. Tucker mound. (Seven-eighths size.)

Vessel No. 3.—Is of about 1 quart capacity and is without decoration save for the protruding head, probably intended to represent that of a wild cat or of a panther (Fig. 216).

Vessel No. 4.—A bowl in fragments, having the check-stamp decoration. This instance, with a single sherd in addition, was the only example of this style of decoration noted by us in the mound.

Vessel No. 6.—Of about 2 quarts capacity, with *repoussé* ridges around the body which has been painted crimson (Fig. 217).

Vessel No. 15.—A quadrilateral vessel with circular upright rim, having in each corner an oblong space, *repoussé*, upon which has been a complicated stamp, now very indistinct.

Vessel No. 19.—An undecorated vase of red ware, hemispherical body with long cylindrical neck ending in four pointed corners.

Vessel No. 20.—A small bowl of inferior ware, with a rude dentate design surrounding the upper part, enclosing punctate impressions (Fig. 218).

Vessel No. 21.—A vase of hemispherical body, with constricted neck decorated with upright parallel ridges, ending in a square rim having incised symbols of the bird (Fig. 219).

FIG. 215.—Vessel No. 2. Tucker mound. (Two-thirds size.)

Vessel No. 22.—This vessel, shown in Fig. 220, is undecorated save for the effigy of the head of a horned owl overlooking the aperture. Length, 8.4 inches; breadth, 6.6 inches.

Vessel No. 25.—Shown in Fig. 221, has a spherical body surmounted by a long, flaring rim. The decoration, incised and punctate, is given in diagram (Fig. 222). Height, 7.2 inches; maximum diameter, 5.4 inches.

FIG. 216.—Vessel No. 3. Tucker mound. (Half size.)

FIG. 217.—Vessel No. 6. Tucker mound. (Half size.)

Vessel No. 28.—A vessel of about 1 pint capacity, with complicated stamp decoration around the neck.

Vessel No. 29.—Somewhat similar in style to the preceding, with a deeper band of complicated stamp decoration around the upper part (Fig. 223).

Vessel No. 31.—A jar with globular body and long neck slightly flaring, surrounded by a complicated stamp decoration (Fig. 224). Height, 8.7 inches; maximum diameter, 5.9 inches.

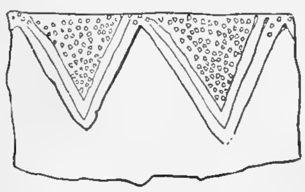


FIG. 218.—Vessel No. 20. Decoration. Tucker mound. (Half size.)

FIG. 219.—Vessel No. 21. Tucker mound. (Half size.)

Vessel No. 36.—This vessel, crimson in color, found crushed to pieces, has been cemented together with slight restorations. It is particularly interesting as belonging to the

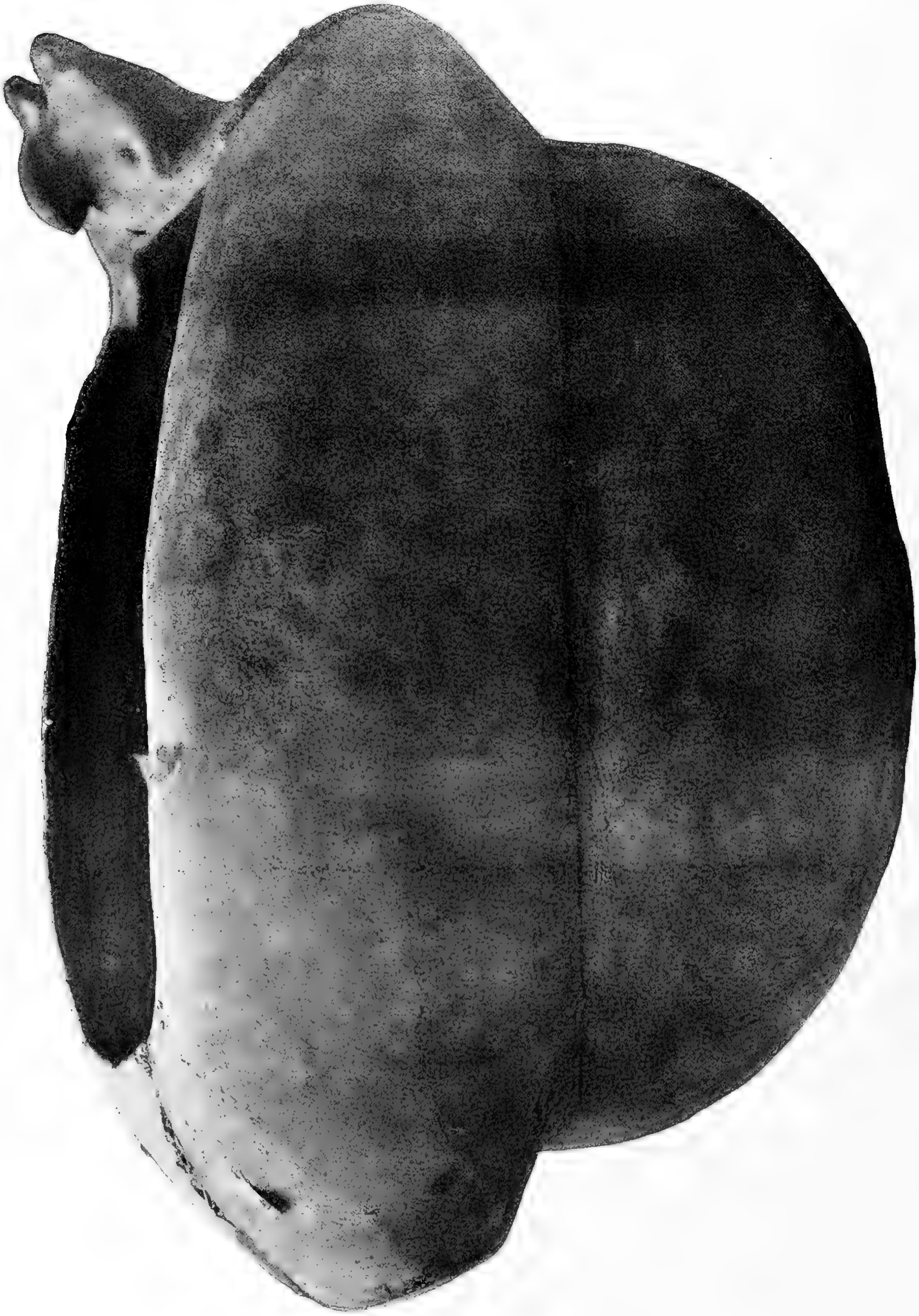


FIG. 220.—Vessel No. 22. Tucker mound. (Full size.)

ready-made mortuary class and has a hole in the base made before baking, as are those in the body and neck of the vessel. This vessel is notable as not being a life-form, to which class ceremonial vessels in this district usually belong. The

FIG. 221.—Vessel No. 25. Tucker mound. (Full size.)

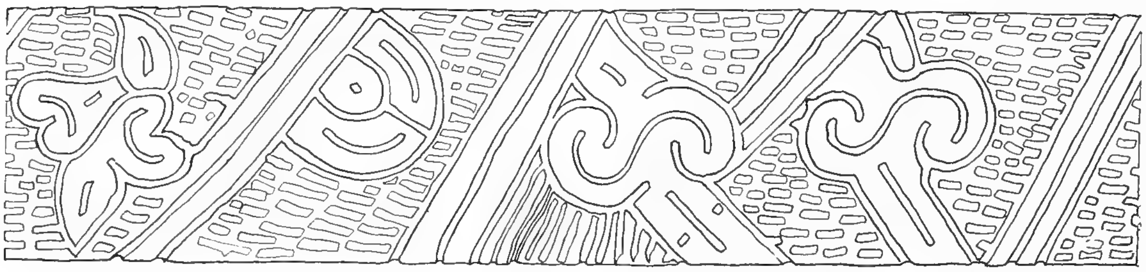


FIG. 222.—Vessel No. 25. Decoration. Tucker mound. (Half size.)

decoration is incised scrolls with punctate and other markings (Fig. 225). Height, 7.3 inches; maximum diameter, 8 inches.

Vessel No. 37.—This vessel, crimson inside and out, was found badly crushed and with parts missing. Cemented together and somewhat restored it seems to be a representation of a shell. On the opposite sides are convolutions similar to those shown in Fig. 226. There have been two perforations for suspension, on one side. Height, 4.2 inches; transverse diameter, 4.8 inches.

FIG. 223.—Vessel No. 29. Tucker mound. (Full size.)

FIG. 224.—Vessel No. 31. Tucker mound. (Half size.)

Vessel No. 38.—Part of a compartment vessel which had originally four circular divisions surrounding a fifth placed on a level above.

Vessel No. 44.—A bowl of excellent ware. The decoration, incised, is shown in diagram in Fig. 227. Maximum diameter, 9.5 inches; height, 6.5 inches.

Vessel No. 57.—A pot almost cylindrical, with flat, square base (Fig. 228). The incised decoration showing the bird symbol often repeated, is given diagrammatically in Fig. 229.

Fig. 225.—Vessel No. 36. Tucker mound. (Five-sevenths size.)

Yent Mound, Franklin County.

This mound, belonging to the Yent estate, Mrs. James Pickett, of Carrabelle, executrix, was in an old field, now overgrown, about one half mile in a southeasterly direction from the Tucker mound.

The mound, beginning SSW. sloped gently upward in a NNE. direction, a dis-

FIG. 226.—Vessel No. 37. Tucker mound. (Full size.)

tance of 68 feet and, continuing at a level 13 feet, had a descent of 25 feet before reaching the flat ground at the NNE., thus having a major axis of 106 feet along the base. At its broadest part, beneath the level portion, the mound was 74 feet across. There were deep excavations at several places along the border of the mound, whence sand had been taken to build it. The height, above what seemed to be the general level, was 7.5 feet.

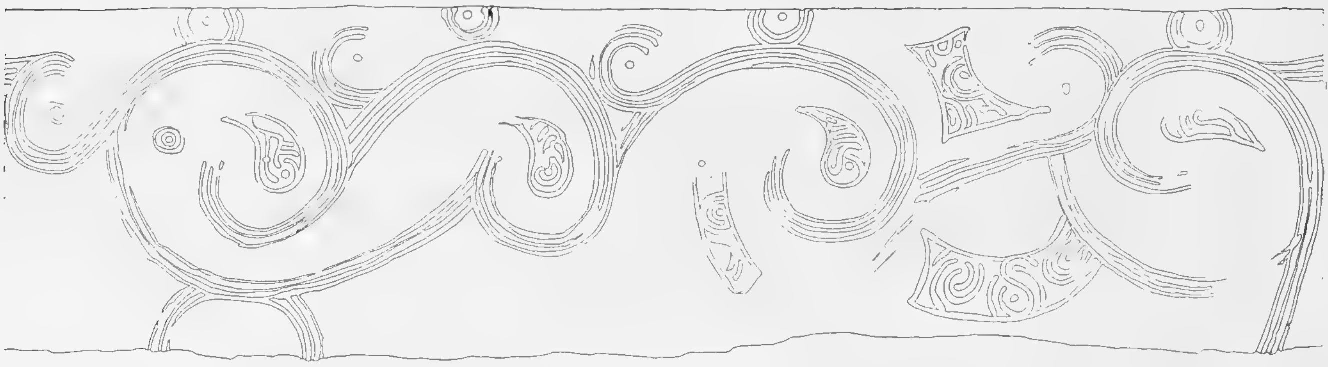


FIG. 227.—Vessel No. 44. Decoration. Tucker mound. (One-quarter size.)

FIG. 228.—Vessel No. 57. Tucker mound. (About full size.)

The mound, which had sustained almost no previous digging, was totally demolished by us.

Human remains were met with in seventy-four places, lying throughout the mound from the very margin, sometimes below the base in graves, along the base, and in the body of the mound, but seldom superficially. There were present

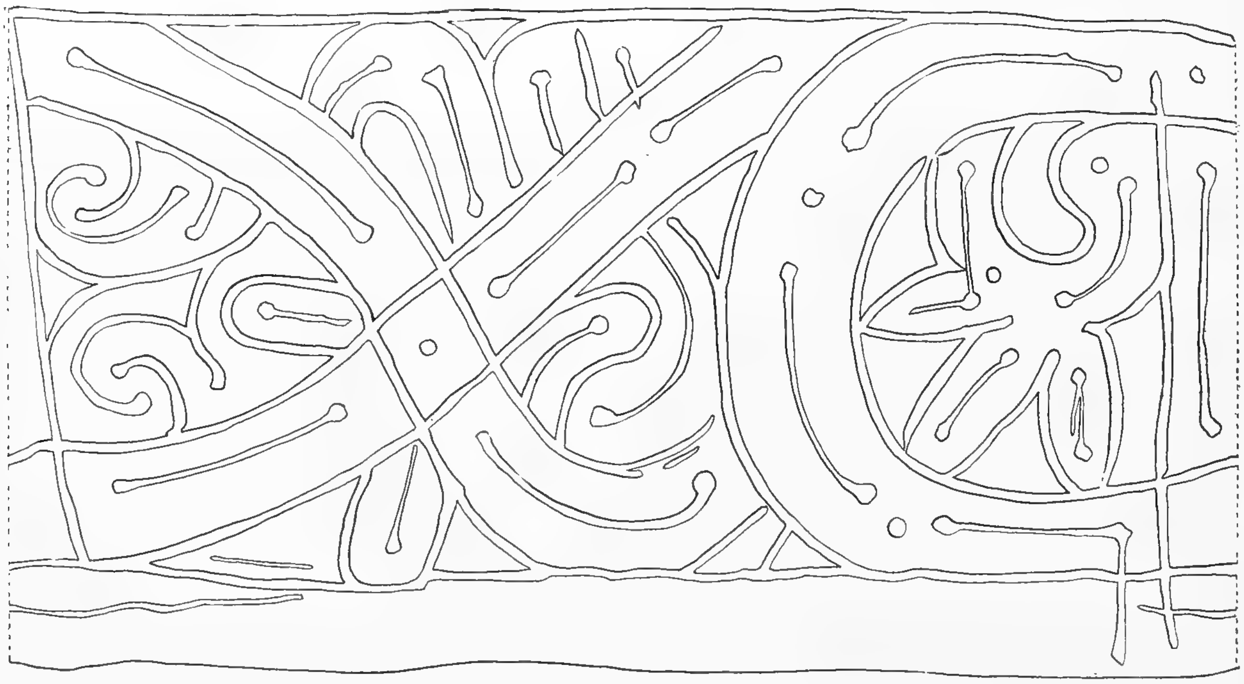


FIG. 229.—Vessel No. 57. Decoration. Tucker mound. (Half size.)

the closely flexed skeleton, the bunch, the lone skull, scattered bones, and skeletons forced into small graves, showing partial flexion at times and, again, disarranged bones with the skull above. There were also bones in caved sand, whose form of burial was not determined, in two or three cases. Though no skulls were saved from this mound, a number were in a condition to allow determination as to cranial flattening. There was no evidence that it had been practised.

Around the great majority of burials were large clam-shells with sometimes a mingling of conchs (*Fulgur perversum*).

Proportionately, the greatest number of burials were marginal, in graves, and with these burials were the most interesting objects in the mound.

With Burial No. 2, a bunch, was a "celt" with a cutting edge 3.5 inches across, while the opposite end tapered gracefully to a blunt point scarcely 1 inch in diameter.

Three other "celts" lay with burials and a small one with a pendant came from a grave where no bones were found though, presumably, lapse of time in wet sand below the base of the mound may account for their absence.

With Burial No. 3, a bunch, were: a canine of a large carnivore; two sheets of mica, roughly shaped to resemble lanceheads; a clam-shell showing wear. A number of such clam-shells with part of the side removed, some with a cutting edge, were met with in this mound.

Burial No. 5, a bunch, had a triangular pebble about 5 inches long, with the greater end showing much use as a hammer.

With Burial No. 8, a mixture of bones, some belonging to an adult, some to a child, near the skull of each was a graceful pendant probably of slate, each about 4.5 inches in length, of the type of a larger one from this mound, to be figured later.

Burial No. 13, a flexed skeleton, had with it four pebbles.

Burial No. 15, a bunch, had with it a rattle made of a turtle-shell holding a number of rather carefully flattened bits of chert.

Burial No. 19, a skull with a single femur, lying in a grave, had a rude earthenware pot some distance above. Probably this association was accidental, as in no other case in this mound was earthenware found with a burial.

With Burial No. 27, a flexed skeleton, were 33 pebbles.

Burial No. 39 consisted of a pit of considerable size, below the base, in which were the flexed skeletons of three adults and parts of skulls and other bones of three infants or children, the remaining bones of these skeletons having doubtless disappeared through decay. At the wrist of one of the adult skeletons were twenty-nine perforated bits of shell, some neatly shaped; seventy-six teeth of the large porpoise (*Turriops turrio*), kindly identified by Prof. F. A. Lucas, of the National Museum, all perforated, some through the enamel, but nearly all through the base of the tooth; and eight pieces of bone, all perforated and more or less rudely made to resemble teeth. With these was a small imperforate tooth of a shark of the present geological period. A selection of these ornaments is given in Fig. 230, the shell being to the left, the bone to the right.

As is so often the case with children in mounds, those in this grave had been especially favored. With one was a pendant, probably of slate, about 5 inches long, of the same pattern as the one next to be described, having bitumen still adhering to the groove. With another was the most interesting pendant it has been our fortune to take from a mound. The material is probably slate. The length is 8.75 inches (Fig. 231). The remaining skull had beside it a gorget of shell cut in the shape of a fish. There are two holes for suspension (Fig. 232). In this grave were also a few shell beads.

Burial No. 42, near Burial No. 39, resembled it in being a large grave below the base, but while No. 39 had a few clam-shells only, scattered here and there above it, this grave was filled in with almost a solid mass of them. The grave contained the flexed skeletons of two adults and the bones of an infant or child, badly crushed, with which was the tooth of a fossil shark, 2 inches long, perforated for use as a pendant.

Burial No. 54, a bunch of bones belonging to an adolescent, had inverted over the skull a perforated shell drinking cup.

With Burial No. 72, bones which fell in caving sand, were fragments of a sheet copper ornament corroded through and through.

With other burials were hammer-stones, hones, pebbles, masses of chert and five or six arrowheads or knives, one of chalcedony, one of quartzite, the remainder of chert.

Also in the mound, in caving sand, so that the proximity to bones could not be

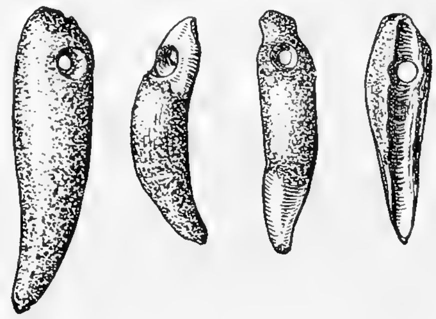


FIG. 230.—Ornament of shell, ornaments of porpoise teeth and ornament of bone. Yent mound. (Full size.)

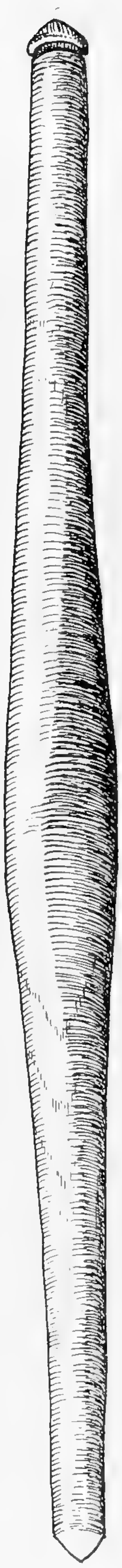


FIG. 231.—Pendent ornament of stone. Yent mound. (Full size.)

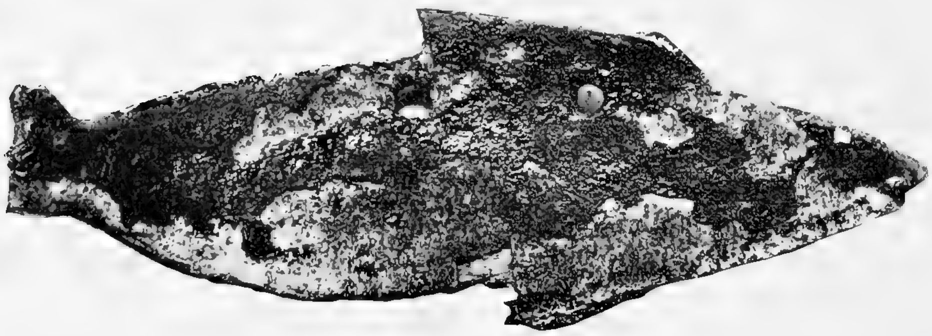


FIG. 232.—Gorget of shell. Yent mound. (Full size)

FIG. 233.—Vessel No. 22. Yent mound. (About full size.)

determined, or in undisturbed sand with no bones present, though they may have gone through decay, were, singly or associated in considerable numbers: masses of chert; rounded hammer-stones of chert; hones of sand-stone; pebbles; pebble-hammers; smoothing stones; a mass of quartz, roughly chipped; several arrow-heads or knives; a handsome pendant 4.5 inches long, similar to the others we have described; part of a "Monitor" pipe of soapstone, highly polished; a pendant chipped from a quartz pebble; a demijohn-shaped pendant made of ferruginous clay-stone; a globular pendant with an arm for suspension projecting from either end; a rude globular pendant of hematite from which the grooved portion has broken; a globular pendant of decomposed material; a barbed lancepoint of brown chert, somewhat over 4 inches in length; a knife of light-brown chert, with curved cutting edge, nearly 9 inches long, from which about 1 inch of the point is missing; shell drinking cups; an ornament of ferruginous sandstone, about 2.5 inches long and 1.5 inches broad, flat on one side, convex on the other, with an unfinished perforation on either face below the middle of one of the longer sides; rude discs of shell; three shark's teeth of the present geological period, two with perforations; double pointed instruments made from axes of marine univalves; three small fossil shark's teeth without perforations; a sheet of mica, rudely given the outline of a lancepoint; rectangular masses of silicified fossil wood, 7 or 8 inches in length, determined by Mr. Lewis Woolman of The Academy of Natural Sciences of Philadelphia, to have belonged to a coniferous tree. One of these was roughly sharpened to a cutting edge; the others had seen service as pestles or hammers.

The earthenware in this mound, of which sixty-seven specimens were noted by us, discarding parts of vessels and heaps of sherds, consisted of common types and of inferior ware. The vessels lay, as a rule, near the base, often numbers together. The first deposit was found at the very margin of the ENE. part of the mound. Later, a considerable deposit lay somewhat in from the margin in the SW. side, while here and there single vessels were encountered throughout the mound. Numbers of vessels lay near the center, short distances apart.

The majority of vessels, undecorated, or with a complicated stamp applied in a faint and slovenly manner, were dropping to pieces when removed. Incised decoration was met with in but five instances and of these but one showed earnestness of endeavor. The features of the earthenware of the mound were the presence of four feet on a large percentage of the vessels and the number of toy pots and bowls found singly, here and there, in the sand, one of which had a diameter of but 1.5 inches.

With but few exceptions all vessels had the basal perforation.

Vessel No. 19.—Small, undecorated, imperforate.

Vessel No. 20.—A toy vessel of very coarse ware, with four feet and rude incised decoration.

Vessel No. 21.—An undecorated vessel of common type, with four feet and notches around the rim, imperforate.

Vessel No. 22.—A cup of heavy ware, with flat, circular base and inward slope to the sides. The decoration consists of punctate impressions around the rim and, a short distance apart, series of upright parallel rows of punctate markings (Fig. 233.)

Vessel No. 28.—A bowl of ware more solid than that of the majority from this mound. The incised decoration is shown in diagram in Fig. 234.

Vessel No. 31.—A vase of rough inferior material, with four feet. The body consists of four *repoussé* lobes. The neck, upright, flares slightly near the margin. There is no decoration.

Vessel No. 37.—A toy bowl having below the rim an encircling incised line with parallel incised perpendicular lines between it and the rim.

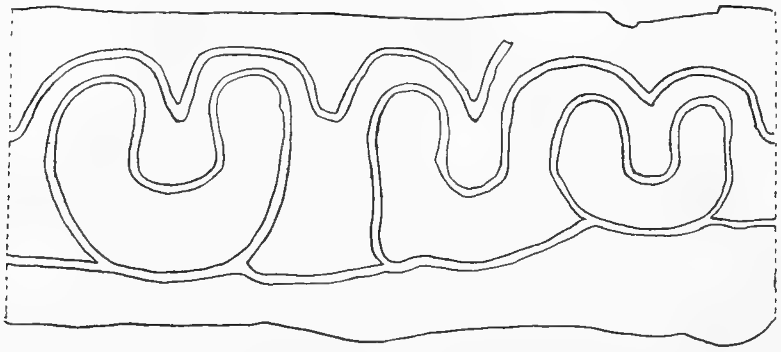


FIG. 234.—Vessel No. 28. Decoration. Yent mound. (Half size.)

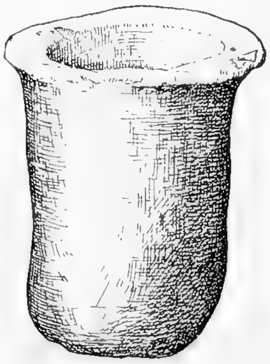


FIG. 235.—Vessel No. 40. Yent mound. (Half size.)

Vessel No. 40.—Cylindrical with flat base, and rim .4 of an inch wide extending horizontally. There are perforations on opposite sides for suspension (Fig. 235).

FIG. 236.—Vessel No. 45. Yent mound. (About full size.)

Vessel No. 45.—A graceful vase of yellow ware, whose basal perforation has removed one of its four feet. The rim is crimped. The decoration consists of perpendicular parallel bands made up of incised crescentic markings (Fig. 236).

FIG. 237.—Vessel No. 55. Yent mound. (Half size.)

FIG. 238.—Vessel No. 62. Yent mound. (Half size.)

Vessel No. 55.—A vessel of ware so solid that three heavy blows of a spade chipped but did not shatter. The form is nearly globular with a certain elongation at one side. The aperture, near which are two holes for suspension on opposite

FIG. 239.—Vessel No. 67. Yent mound. (Full size.)

FIG. 240.—Sherd. Yent mound. (Three-fourths size.)

sides, is but .8 of an inch in diameter. The decoration, incised and punctate, with light-colored material inset, consists of a rudely executed design, evidently symbolical, four times repeated (Fig. 237). Height, 4.2 inches; maximum diameter, 4.5 inches.

Vessel No. 62.—A vessel of inferior ware, with four feet. The decoration seemingly is cord-marked (Fig. 238).

Vessel No. 67.—The most carefully decorated vessel in the mound, with flat base on which the decoration on the body is continued. A part of the body and neck, missing when found, has been restored (Fig. 239).

A sherd from this mound is shown in Fig. 240.

Mound on Marsh Island, Wakulla County.

Marsh Island is the northeastern boundary of Ocklockonee bay. The mound was in full sight of the water about 100 yards distant, on property of the Rayker family of Crawfordville, Fla. The usual deep excavations near the mound were present and extensive shell deposits were in the neighborhood.

The mound, which gave little evidence of previous digging, oblong with rounded corners, was 96 feet through the base in an easterly and westerly direction, 68 feet in a northerly and southerly, and had a height of 7 feet. The mound was entirely demolished by us.

Human remains were present at 106 points and their discovery began at the very margin of different parts of the mound. Many burials lay in the eastern portion, but interments in graves below the base were much more numerous on the western side. But few burials were met with in the northern and southern parts of the mound.

There were twenty-five lone skulls, some in little graves of their own below the base, and, in two instances, two skulls lay together without other bones. The flexed burial was met with in twenty-eight instances and the bunch was present forty-four times, counting under this heading masses of bones indiscriminately mixed, including numbers of skulls. There were also several disturbances of remains, probably aboriginal, and cases where bones fell in caved sand before the form of burial was determined. There was also one urn burial.

The question of cranial flattening in this mound will be discussed later.

Thirteen burials lay under oyster-shells sometimes few in number, sometimes in a solid mass. Noteworthy burials, including all associated with artifacts, were as follows:

Burial No. 20—A lone skull had with it a graceful "celt."

Burial No. 24 had a bit of chert in association.

Burial No. 37, a flexed skeleton, lay in a grave below the base. With it was a mass of plumbago, deeply pitted.

Burial No. 38.—A lone skull lay with a "celt."

Burial No. 51, in a grave beneath oyster-shells, consisted of three flexed skeletons, two on the same level, one somewhat above. With them was the knucklebone of a deer.

Burial No. 59, a mass of bones including fourteen femurs and four skulls.

Burial No. 66, a flexed skeleton, had with it a bit of plumbago.

Burial No. 70, four skulls and a lot of long-bones, 2.5 feet below the surface. With them were a pair of scissors and other articles, of iron or steel, badly rusted, glass beads, one large shell bead, one copper or brass sleigh-bell, eleven tubular beads of sheet brass, with overlapping edges. Dr. Harry F. Keller, who made a qualitative analysis of one of these beads, writes: "The tube surrounding the cord is brass. Beside a large proportion of zinc, it contains considerable quantities of lead, silver and iron."

Burial No. 85, about 2.5 feet down, had seven skulls and eighteen femurs with other bones. One small glass bead lay with them and doubtless others were in the sand.

Burial No. 92, had seven skulls with other bones. Articles of iron and of steel were in association.

Burial No. 93, a bunch, had a stone implement with a rude cutting edge, two pebbles and two pebble hammers.

Burial No. 104 had certain burnt and calcined human bones mixed with others unaffected by fire. Above, in the sand, extending a considerable distance upward were masses of charcoal. This may have been a case of cremation or of proximity to ceremonial flames.

Burial No. 105, near the surface, had eleven skulls and many other bones. With them were three copper or brass sleigh-bells, articles of rusted iron or steel and three shell hair-pins.

Burial No. 91, a true urn-burial, was of much interest to us, in that it carried the occurence of the custom so much farther east in Florida.

About 3 feet from the surface, that is to say 3 feet to where the base of the under vessel rested, was an imperforate bowl of solid, but rather coarse ware, 6.75 inches high and 10.75 inches in maximum diameter. The decoration, incised, is carelessly executed. Within the bowl were the bones of an infant. Around each humerus was a bracelet of sheet brass, about 2.25 inches in diameter and 2 inches wide, having two perforations on either side to regulate the diameter by aid of a cord or sinew. Over the bowl, inverted, was another bowl of similar ware and with decoration as carelessly done, imperforate, with two projections at either side. Maximum diameter, 12 inches; height, 4.7 inches (Fig. 241).

In the Marsh Island mound was shown in an interesting way, in our opinion, the use often made of a mound for intrusive burial. In this mound nearly all burials lay below the base in graves or on the base, or not far above it but no burial of this class had with it a single object of European provenance.

Five burials came from near the surface and one from a pit whose base was 4 feet below the surface, but whose filling in from the surface down was clearly marked by admixture of masses of charcoal.

Of these six burials (we are omitting the urn-burial) four had with them various articles unmistakably obtained from the whites, and glass beads, which

undoubtedly belonged to another of them, were found in the sand near where it had lain. The sixth burial came from near the surface in much caved sand and associated objects could not be definitely located.

The 106 burials in the mound represented a great number of skulls. Of these skulls a large percentage were so crushed that no determination as to flattening could be arrived at, but on no skull coming from on or near the base was any sign of flattening noticed, while the skulls belonging to the six burials to which we have already referred were as follows:

FIG. 241.—Urn-burial (Burial No. 91.) Mound at Marsh Island. (Half size.)

Burial No. 61.—One skull, flattened.

Burial No. 70.—Four skulls, all badly crushed.

Burial No. 85.—Seven skulls. In the evening of the day when this burial was removed, while writing our amplified notes, we found no reference to cranial flatten-

ing in connection with this burial, in the note book used by us at the mound, but it was the strong impression of the one who removed the bones and of ourselves, who saw the bones removed, that such skulls as were not badly crushed, showed flattening and that our failure so to state in our notes was an omission, simply.

Burial No. 92.—Seven skulls, six of which showed flattening; the other was badly crushed.

Burial No. 104.—Three skulls, one flattened, two crushed.

Burial No. 105.—Six skulls flattened; five hopelessly crushed.

Here, then, we have clearly enough, superficial burials with flattened skulls and European artifacts on one hand, and on the other, original burials whose skulls showed no flattening and with which were no articles giving evidence of European contact.

Two "celts" fell in caved sand, doubtless from the neighborhood of human remains.

There were also in the mound, unassociated when found: a few fragments of chert; a small bit of plumbago; mica; scattered pebbles; a deposit of twenty-four pebbles, sling-stones, no doubt; pebble-hammers; hones; a bit of shell; a rude cutting implement; a handsomely made disc of quartzite, cup-shaped on either side, 3 inches in diameter, .85 of an inch in thickness. Each concavity has a depth of .25 of an inch. While objects of this sort are not uncommon in other parts of the country, this is the first found by us during our mound work.

Sand, pink from admixture of hematite, was in the mound in one or two places, unassociated with burials.

At the eastern margin of the mound were a few sherds, one of excellent ware, showing incised decoration. There were also parts of four vessels with practically similar ornamentation consisting of rude animal heads upright around the rim with incised lines and punctate markings below.

Four or five undecorated pots and bowls were found here and there in the mound, unassociated with human remains.

On the eastern side, 24 feet in from the margin, began a deposit of earthenware which, spreading a little to either side, continued in a distance of about 13 feet. These vessels, lying along the base in masses of black sand, as a rule away from human remains, had the basal perforation with three exceptions.

Fig. 242.—Vessel No. 1. Mound at Marsh Island. (Half size.)

Forty-four vessels were noted by us, accompanied by the usual sherds. The ware was most inferior, so porous in cases that water actually could be pressed from

it. The majority of vessels, entirely undecorated or bearing a faint complicated stamp, fell into bits on removal. Incised decoration was most infrequently met with.

Vessel No. 1.—A bowl, with inverted rim, is of exceptionally good ware for this

FIG. 213.—Vessel No. 2. Mound at Marsh Island. (About two-thirds size.)

mound. The decoration, incised, consists of six rude diamonds enclosing four formed by single incised lines and two by double ones. Upright and central in each diamond, in a field of horizontal parallel straight lines is the emblem of the bird.

Between the lower parts of the diamonds are triangles, sometimes of one line, sometimes of two, containing horizontal parallel lines. Capacity about 1 quart (Fig. 242).

Vessel No. 2.—A ceremonial vessel of inferior ware, representing the head, body and tail of a bird. In addition to the basal perforation made before the hardening of the clay, there are similarly constructed holes in the body of the vessel. The exterior surface has been covered with crimson paint (Fig. 243). Height, 10.2 inches; maximum diameter, 6.5 inches.

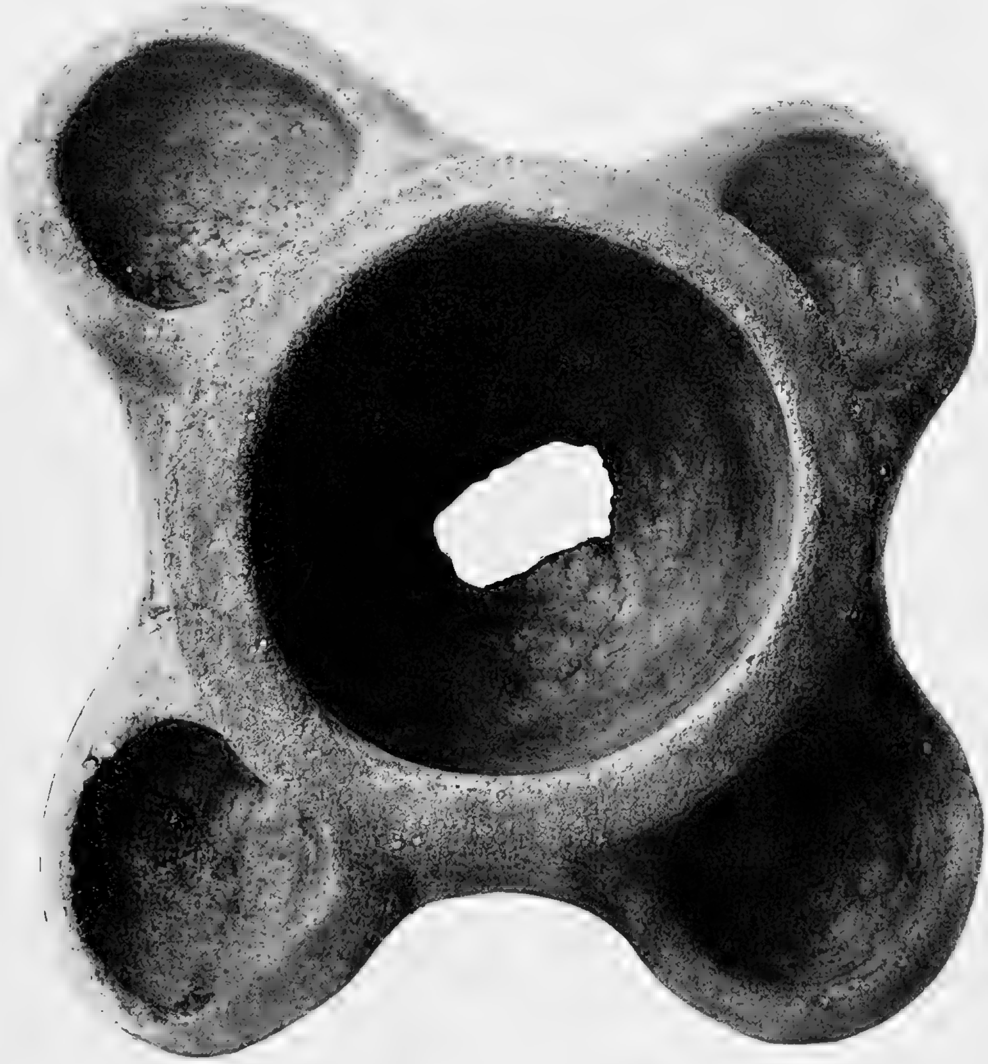


Fig. 244.—Vessel No. 20. Mound at Marsh Island. (Five-eighths size.)

Vessel No. 7.—A compartment vessel or part of one, found almost in a pulpy condition.

Vessel No. 8.—A large flattened sphere of red ware, undecorated, which crumbled to bits on removal.

Vessel No. 20.—A compartment vessel having a large central compartment rising above four smaller ones (Fig. 244). A cross-section is shown in Fig. 245.

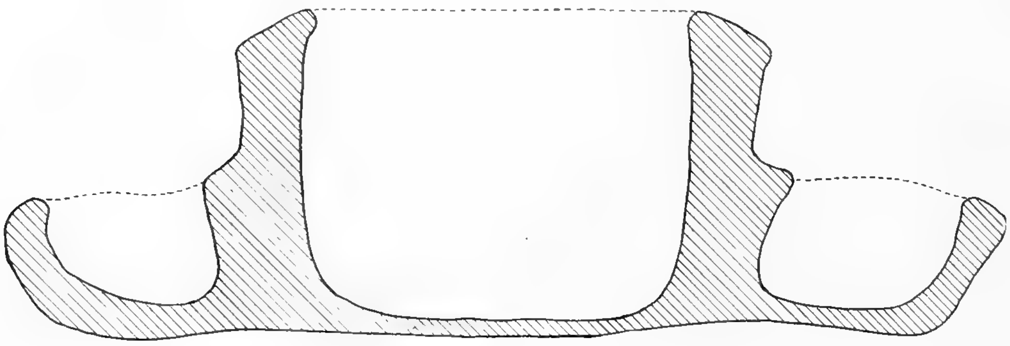


Fig. 245.—Vessel No. 20. Vertical section. Mound at Marsh Island. (Half size.)

Fig. 247.—Vessel No. 37. Decoration. Mound at Marsh Island. (One-third size.)

Fig. 248.—Sherd. Mound at Marsh Island. (Four-fifths size.)

Fig. 246.—Vessel No. 34. Mound at Marsh Island. (About three-fourths size.)

Vessel No. 33.—A pot of yellow ware, of about 1 pint capacity with four encircling lines of oblong impressions below the rim.

Vessel No. 34.—Two parts of this vessel, having no surface indicating the former junction, were found some distance apart. The restoration is an arbitrary one as the length of the cylinders which joined the globular extremities could be estimated only (Fig. 246).

Vessel No. 36.—A large pot 15 inches across the mouth, which fell into bits before farther measurement could be obtained.

Vessel No. 37.—A vessel of ordinary form, with rude punctate markings below the rim, shown diagrammatically in Fig. 247.

A sherd from this mound with complicated stamp is shown in Fig. 248.

Nichols' Mound, Wakulla County.

The estate of Mr. Eli Nichols is situate on the north side of Ocklockonee bay near where the Sopchoppy river unites with the bay.

The principal mound, in a cultivated field not far from Mr. Nichols' residence, is about one-half mile from the landing, in a northerly direction.

The mound, which had suffered no digging except from insignificant efforts of children on the place, was 5.5 feet in height and had a basal diameter of 100 feet save to the SW. where a graded way 12 feet long and about 22 feet across, joined it.

It was our belief from the start that this mound, which covered an area disproportionate to its height and which had a great level summit plateau, had been made for domiciliary purposes. To assure ourselves of the fact, however, and to learn, it our surmise proved true, whether or not a dwelling site had been used for burial purposes, as we have sometimes found to be the case, twenty men on an average worked for two days on the mound, trenching in every direction.

The mound, of dark brown sand, had a thin layer of small clam-shells (*Rangia cuneata*) along the base and, beginning at a certain distance in, another layer of the same kind of shells, about 1 foot in thickness which, at the starting point, was about 1 foot below the surface but three times that depth at the center of the mound.

Burials were all superficial. In the slope and in the outer part of the summit plateau they lay just below the upper shell layer and in each case the layer had been cut through to bury them. In the more central part of the mound the burials lay above the shell layer.

Thirty-three burials were met with during the trenching. Twenty-two were closely flexed. One lay on the back with the knees flexed upward. Six were not exactly determined as to form of burial owing to disturbance either aboriginal in making another grave or by recent digging or by caving sand. Four lay at full length on the back, in each case the feet pointing toward the margin of the mound. Whenever skulls were in a condition to be examined artificial flattening was noted.

Burial No. 7.—A flexed skeleton had a femur the neck of which had formerly sustained a fracture. This bone was sent to the United States Army Medical Museum, Washington, D. C.

Three burials had each a "celt;" one had shell beads while with several were pebble-hammers and flakes of chert.

Unassociated and near the surface, as were all artifacts found in this mound, were three "celts," two together; a bit of chert, with a cutting edge; a mass of galena, considerably larger than a closed hand; a bit of chert, roughly rounded; an interesting finger-ring which seemed to us made from the vertebra of a large fish, as a small groove or band surrounded it. This ring was sent to Prof. F. A. Lucas of the National Museum who kindly devoted considerable time to it. Professor Lucas reports the ring to be a veritable puzzle. It is not bone or shell or vegetable ivory. "It is very likely some large palm seed like the so-called 'sea beans' that come to the Florida coast, and this would account for the curious band, almost continuous, that runs around the rim."

Several sherds were present in the mound, coming probably from midden refuse. The complicated stamp and the small check stamp were represented and there was also a handsome fragment of excellent ware decorated with a circular band of crimson, in which was a circle of punctate markings. One sherd bore a loop-shaped handle.

In sight of Mr. Nichols' house, in an easterly direction from it, was a low ridge in pine woods, seemingly of artificial origin. A few human bones and the base of an undecorated pot were the sole results of careful trenching.

In a field bordering the water, also belonging to Mr. Nichols, near the landing was a mound 34 feet across the base and 4 feet high, through which a small and shallow trench had been dug previous to our visit. In the neighborhood of the mound, both in the field and along the shore, are numerous deposits of shell, some of the oyster but mainly of a small clam (*Rangia cuneata*). All remaining parts of the mound were demolished by us without discovery of artifacts or burials.

This mound was made of mud, probably from the river, with a small admixture of sand and was so solid that picks and axes were employed in its demolition.

Mound near Ocklockonee Bay, Wakulla County.

At the southwestern extremity of Ocklockonee bay are ridges of sand unusually high for this level district. On one of these, at the top, is a mound about 18 inches high and 35 feet across approximately. It had been thoroughly dug into from all sides. Fragments of human bones and bits of aboriginal ware lay on the surface. No investigation was attempted by us.

Hall Mound, Panacea Springs, Wakulla County.

Panacea Springs, a health resort with many mineral springs, is at the head of King's bay, a part of Apalachee bay.

In pine woods and scrub, about 1 mile in a northeasterly direction from the land-

ing at the Springs, near a large shell-heap, is a mound on property of Mr. Thomas H. Hall, the owner of the Springs, who resides on the place.

The mound, of circular outline, had a basal diameter of about 60 feet. A former excavation in the center of the summit plateau, though filled, seemingly had lessened the original altitude. At the time of our visit the mound was eight feet high. The excavation, the only one previous to our own, was circular with a diameter at the top of from 10 to 12 feet. At a depth of 4 feet it was 8 feet across. It had a diameter of 2 feet 5.5 feet down, where it ended. Joining the mound on the western side was a causeway 60 feet long, 24 feet of which was a graded ascent at the western end. The remainder of the causeway was level until its union with the mound. The causeway, about 5 feet in height, was 47 feet wide at the start, diminishing about 10 feet later, owing to great excavations on either side, whence sand for the causeway or mound had been taken.

The mound was totally demolished by us as was the causeway with the exception of the 24 feet of slope, which were trenched by six men without result save the discovery of a recent burial with parts of a coffin and nails.

We shall first take up the causeway. No burials were found in the marginal parts or in the sides. In the southwestern part, at the union of the slope with the flat surface, was a bunched burial near the base. About 30 feet in from the end of the causeway and about 5 feet from the surface, was a small bunch of bones including a skull. Near these lay two pendants, one of igneous rock, the other made from a quartz pebble, each about 2 inches in length. Their shape is roughly ellipsoidal, each with an extended end around which is a groove for suspension. Near the base, at different points, were two lone skulls.

Under the sloping sides of the causeway were several vessels from which considerable parts were missing. Had it not been that the basal perforation was present in them there would have been grounds to consider them broken and cast aside during the making of the mound.

A number of vessels, none equalling in excellence of ware or decoration the better vessels of the mound proper, were found in the main, or flat portion of the causeway. Some of these will be particularly described with the vessels from the mound proper.

There were also in the causeway one shell drinking cup and two masses of plumbago, deeply pitted.

In the mound proper, beginning at the very margin of the eastern side and confined almost exclusively to that side, were thirty-one burials, including, as to form, the flexed, the bunch, the lone skull. Several were too badly decayed to allow determination and several others came down in caved sand. So badly decayed were the bones that no whole skull or considerable part of a skull was met with, but careful examination of such fragments as were found, discovered no sign of flattening.

The custom to put oyster-shells over burials was chiefly honored in the breach in the Hall mound. Several burials had a few shells lying with them, but two or three only had masses of oyster-shells above them, such as we have found elsewhere.

Practically no artifacts lay with burials. It would seem as though friends of the departed, in placing the general tribute of earthenware, which we shall speak of later, considered themselves released from farther duties in the matter.

Near Burial No. 1, a small bunch with a few oyster-shells, were two "celts."

Burial No. 2, a few bones, had a small number of shell beads and beads were with Burial No. 12, a bunch.

Burial No. 3 had two earthenware vessels nearby but, as a general deposit of earthenware was in that part of the mound where the burial lay, the proximity may have been accidental.

A feature in the mound was the comparative absence of material ordinarily met with. The usual hones, masses of chert and the like were absent. There were found: one "celt" in caved sand; two small masses of lead sulphide; two pebble-hammers; one smoothing stone; one hammer-stone; one bit of plumbago; one perforated shell drinking cup. In a quantity of sand dyed with hematite, the only occurrence in the mound of the red oxide of iron noted by us, was a sheet of mica, shaped to resemble a lancehead.

Beginning at the very edge of the mound, almost due E., and extending slightly toward the N. and toward the S. as the digging advanced, was a deposit of earthenware unassociated with burials, on or near the base, in masses of dark sand sometimes almost of inky blackness. The result of the analysis of this sand is given elsewhere in this report.

This earthenware, as usual, was made up of vessels badly broken of which all parts were present; of single portions of vessels; and of fragments which, when put together, formed only part of a vessel. Here and there with these were specimens of unbroken ware.

Sixty-eight vessels or large parts of vessels, whole and broken, were noted by us in the mound and in the causeway. Had the average of excellence of ware and of workmanship of all vessels in the mound equalled that of the first twenty found by us and of the sherds among which they lay, the record of the mound would have been unique, since many pieces fully held their own with the best ware of the Gulf. As it is, the Hall mound may be considered to hold its own with any opened by us.

The occurrence of this excellent ware was during the digging of the first few feet and the entire deposit of earthenware, which had degenerated into ordinary types, undecorated or with the complicated stamp, practically ended at a point about 22 feet in from the margin, though a few vessels were met with later. All this deposit, so far as noted, had the basal perforation made before or after baking of the clay. There were present, however, here and there in various parts of the mound and of the causeway vessels near the surface or at all events much higher than the general deposit which, as we have stated, lay along the base. A few of these scattered vessels had the basal perforation, but the majority had not, ten having been found without it.

Among the sherds, near the margin of the mound, were many birdhead handles, and fragments of ceremonial vases through the bases and bodies of which perforations had been made before baking.

We shall now describe in detail the most noteworthy vessels from the Hall mound.

Vessel No. 1.—A bowl of excellent heavy yellow ware of about 3 pints capacity (Fig. 249), with complicated incised and punctate decoration consisting of two series, one on either side, separated by undecorated spaces (diagram, Fig. 250).

Fig. 249.—Vessel No. 1. Hall mound. (Full size.)

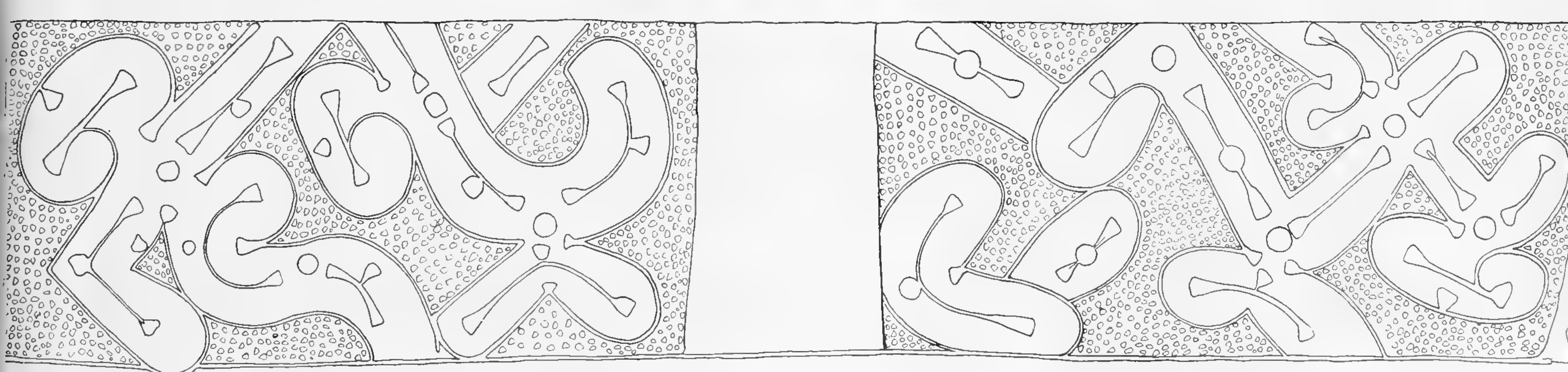


Fig. 250.—Vessel No. 1. Decoration. Hall mound. (Half size.)

Vessel No. 3.—A vase of interesting shape having three lobes joined by a cylinder to a much flattened sphere (Fig. 251). The decoration, incised and punctate, is practically the same on two of the lobes, with a certain variation on the third.

FIG. 251.—Vessel No. 3. Hall mound. (About full size.)

On the upper part of the vessel the design is repeated on the opposite side. There have been two holes for suspension. Height, 6.5 inches; maximum diameter, 5 inches.

Vessel No. 5.—A bowl of about 2 gallons capacity, found crushed but since put

together. There is incised decoration on the upper part of the body as shown in Fig. 252.

Vessel No. 6.—Near the surface was a vessel of thick ware, made up of two circular compartments, one higher and broader than the other. Both are perforated (Fig. 253).

FIG. 252.—Vessel No. 5. Hall mound. (One-third size.)

Vessel No. 7.—A cylindrical body surmounted by a bird-effigy. The wings, *repoussé*, are decorated with the symbol of the bird. The head, that of a duck, is rather rudely done. The tail projects. This vessel belongs to the class made expressly for burial with the dead, having a hole in the base and four triangular

FIG. 253.—Vessel No. 6. Hall mound. (Full size.)

holes in the body made when the clay was soft (Fig. 254). Height, 9 inches; maximum diameter of body, 7.7 inches.

Vessel No. 8.—A much flattened sphere of yellow ware with circular aperture originally about 1 inch in diameter, but now elongated on two sides owing to the breaking away of the margin on either side by a cord or sinew used for suspension.

Fig. 254.—Vessel No. 7. Hall mound. (About three-fourths size.)

The decoration, shown in Fig. 255, is rudely executed. A material, probably yellow clay, has been inset in the line and punctate markings.

Vessel No. 10.—A bird-effigy vessel with the upper part of the body and head missing, when found. The body has since been restored and a head found not far distant in the mound, and seemingly belonging to the vessel, has been added. The ware is inferior. The outside has a covering of crimson paint. Throughout the body are triangular holes made before baking, as was the small triangular one in the base (Fig. 256).

Fig. 255.—Vessel No. 8. Hall mound. (About five-sixths size.)

Vessel No. 11.—A bowl of about 2 gallons capacity has four incised designs, those on opposite sides being similar. The two different designs are shown diagrammatically in Fig. 257.

Vessel No. 12.—An oblate-spheroidal body with upright neck (Fig. 258). The decoration, incised to an unusual depth, complicated and interesting, is shown diagrammatically in Fig. 259. It will be remarked that seven groupings running downward resemble each other, with minor points of difference only, and that three groupings extending upward are also much alike, though not entirely so. There are four blank spaces which the aboriginal artist, presumably, did not take time to fill. The vessel, found crushed into many fragments, has been carefully cemented together.

Vessel No. 13.—This vessel, a bird-effigy, belonging to the ready-made mortuary variety, had, when found, a considerable part of the body and tail broken and

absent. These portions have since been restored (Fig. 260). Around the lower part of the vessel is a rattlesnake in relief, given diagrammatically in Fig. 261, with head, rattles and button distinctly shown. On the head and tail of the reptile are symbols of the bird. While these may be intended to designate the plumed serpent,

Fig. 256.—Vessel No. 10. Hall mound. (About two-thirds size.)

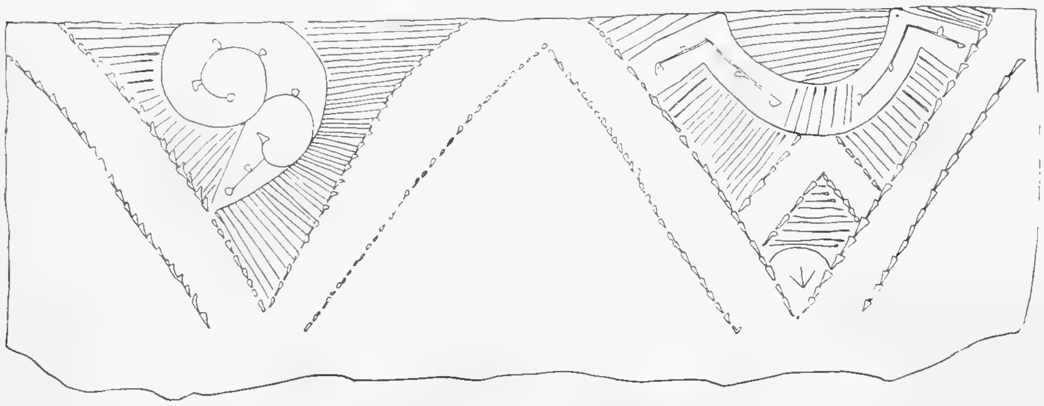


FIG. 257.—Vessel No. 11. Decoration. Hall mound. (One-third size.)

FIG. 258.—Vessel No. 12. Hall mound. (Half size.)

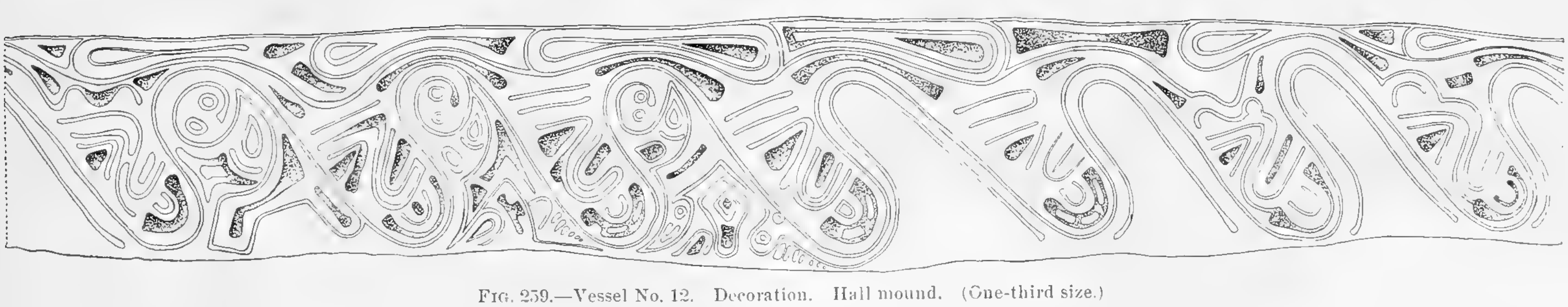


FIG. 259.—Vessel No. 12. Decoration. Hall mound. (One-third size.)

FIG. 260.—Vessel No. 13. Hall mound. (About three-fifths size.)

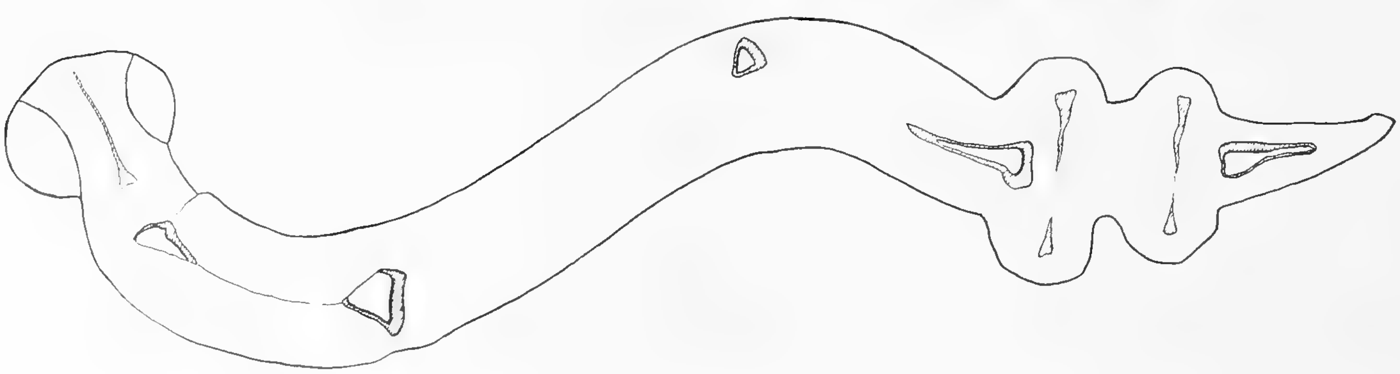


FIG. 261.—Vessel No. 13. Decoration. Hall mound. (Half size.)

which is sometimes depicted in aboriginal art,[1] yet, as we have stated, Professor Holmes has shown that the aborigines were not always consistent in their decorations. Hence the bird symbol in this case may have been used as an ornament solely. In the former part of this report, we spoke of the reverence shown the rattlesnake by Florida Indians, as recounted by William Bartram, and cited the statement by Captain Romans, when writing on Florida, that he had never seen a savage wittingly injure a snake. Adair speaks of the veneration of southern Indians for the serpent and we are told how the aborigines of the St. Johns river, Florida, treated with every mark of respect the head of a serpent cut off by a soldier of de Gourgues.[2]

Fig. 262.—Vessel No. 16. Hall mound. (Half size.)

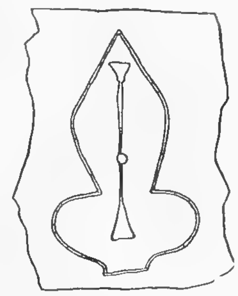


Fig. 263.—Vessel No. 16. Decoration. Hall mound. (Half size.)

Vessel No. 16.—A quadrilateral cup with rounded corners and curved rim. Part of the base, which has been flat, is missing (Fig. 262). The decoration shown in the half-tone is uniform throughout, save at one place, where a species of trefoil occurs (diagram, Fig. 263).

Vessel No. 17.—A vase of about six quarts capacity, of excellent yellow ware, having a carefully executed incised decoration as shown in Fig. 264. On the rim are four projections, perhaps rudimentary effigy-handles.

Vessel No. 20.—Another example of ready-made mortuary ware of the usual half-baked clay. In form the vessel is an inverted truncated cone having above it an effigy of a horned owl. The wings, broken in parts, when found, have been cemented, with missing portions restored. There are a ready-made perforation of base and triangular openings at various places in the body of the vessel (Figs. 265, 266).

Vessel No. 26.—This vessel, with imperforate flat base, fell with caving sand. In form the vessel is a truncated pyramid inverted. The rim, which has slight incised

[1] Two superb examples of the highly conventionalized plumed serpent were found by us engraved on vessels in a mound in Cooper's field, not far from Darien, Ga., and are described in our "Certain Aboriginal Mounds of the Georgia Coast."

[2] "*La Reprinse de la Floride,*" *par le Capitaine Gourgues.* Cited by Brinton.

decoration, projects somewhat inside and out. The decoration, incised, consists of series of parallel lines, three such series on one side, four on the side shown in Fig. 267. There are two perforations below the rim on the same side.

Vessel No. 27.—An imperforate compartment vessel which fell with caving sand, presumably from a superficial part of the mound. A central compartment rises above four surrounding ones (Fig. 268).

Vessel No. 28.—A vessel of 6 quarts capacity, quadrilateral with rounded corners and square imperforate base, slightly concave. The decoration consists of an incised encircling line below the rim. This vessel fell with Vessel No. 27.

FIG. 264.—Vessel No. 17. Hall mound. (Six-sevenths size.)

FIG. 265.—Vessel No. 20. Front view. Hall mound. (Six-sevenths size.)

Vessel No. 30.—Of eccentric form, undecorated (Fig. 269). Height, 8.8 inches; maximum diameter, 5 inches.

Vessel No. 32.—From near the surface came an interesting imperforate vessel having a large circular compartment raised above three others with a fourth com-

Fig. 266.—Vessel No. 20. Side view. Hall mound. (About seven-tenths size.)

partment missing. This vessel, we believe, has been a life-form, a semi-circular compartment at either side of the main one standing for wings, while a more pointed one behind indicates the tail. Unfortunately, the compartment representing the head is the missing one.

FIG. 267.—Vessel No. 26. Hall mound. (Half size.)

Vessel No. 35.—A cylindrical vessel of yellow ware of about 2 quarts capacity, the decoration consisting of an arrangement of zigzag bands and diamond-shaped figures (Fig. 270). Certain bands and the larger diamonds are the yellow color of the ware, while other bands and the smaller diamonds are colored crimson. This vessel somewhat recalls many others of the same shape recently found in southwestern United States.

Vessel No. 39.—A hemispherical body and constricted neck around which runs a band of complicated stamp decoration (Fig. 271).

Vessel No. 42.—A pot of about 3 quarts capacity, having a complicated stamp decoration as shown in Fig. 272.

Vessel No. 50.—Quadrilateral with square, imperforate base and constricted neck. Around the upper part of the body is a band of complicated stamp decoration about 1.5 inches broad. This vessel fell from near the surface in caving sand.

Vessel No. 53.—A vessel of solid yellow ware with flat imperforate base, with decoration consisting of designs each composed of three concentric triangles, the inner one in each case being deeply cut. There are two holes on opposite sides for suspension (Fig. 273).

Vessel No. 57.—A vessel of about 3 pints capacity, undecorated save for a graceful scallop around the rim.

Vessel No. 63.—Has three compartments as shown in Fig. 274. The ware is unusually heavy. This vessel, which is imperforate, came from caving sand in the causeway. Length, 8.5 inches; height, 1.7 inches.

Vessel No. 64.—An effigy of the human figure from the waist down, parts of which were missing when found, the remainder having been restored. This may have been an entire figure which, broken later, has had the irregular margin of the fracture smoothed down to allow the remainder of the vessel still to be of use (Fig. 275).

Vessel No. 65.—This bowl, of inferior ware, found badly broken in the causeway, is of interest in that it presents a combination consisting of a decoration in relief beneath the rim and a faint complicated stamp extending 2 inches farther below (Fig. 276).

With Burial No. 23, in a pit below the base, were two skulls at opposite sides

of the grave. With them was a large effigy of the head of a horned owl, colored crimson, broken from a vessel, no parts of which were present in the grave. The pointed horns have the inner portion excised (Fig. 277).

In Figs. 278, 279, 280 are shown three bird-head handles found unassociated in the mound.

In Fig. 281 is given part of a vessel from this mound which has had beautifully incised decoration, in part representing wings with the symbol of the bird. Side by side on the fragment, are two heads probably modelled after that of a vulture. The

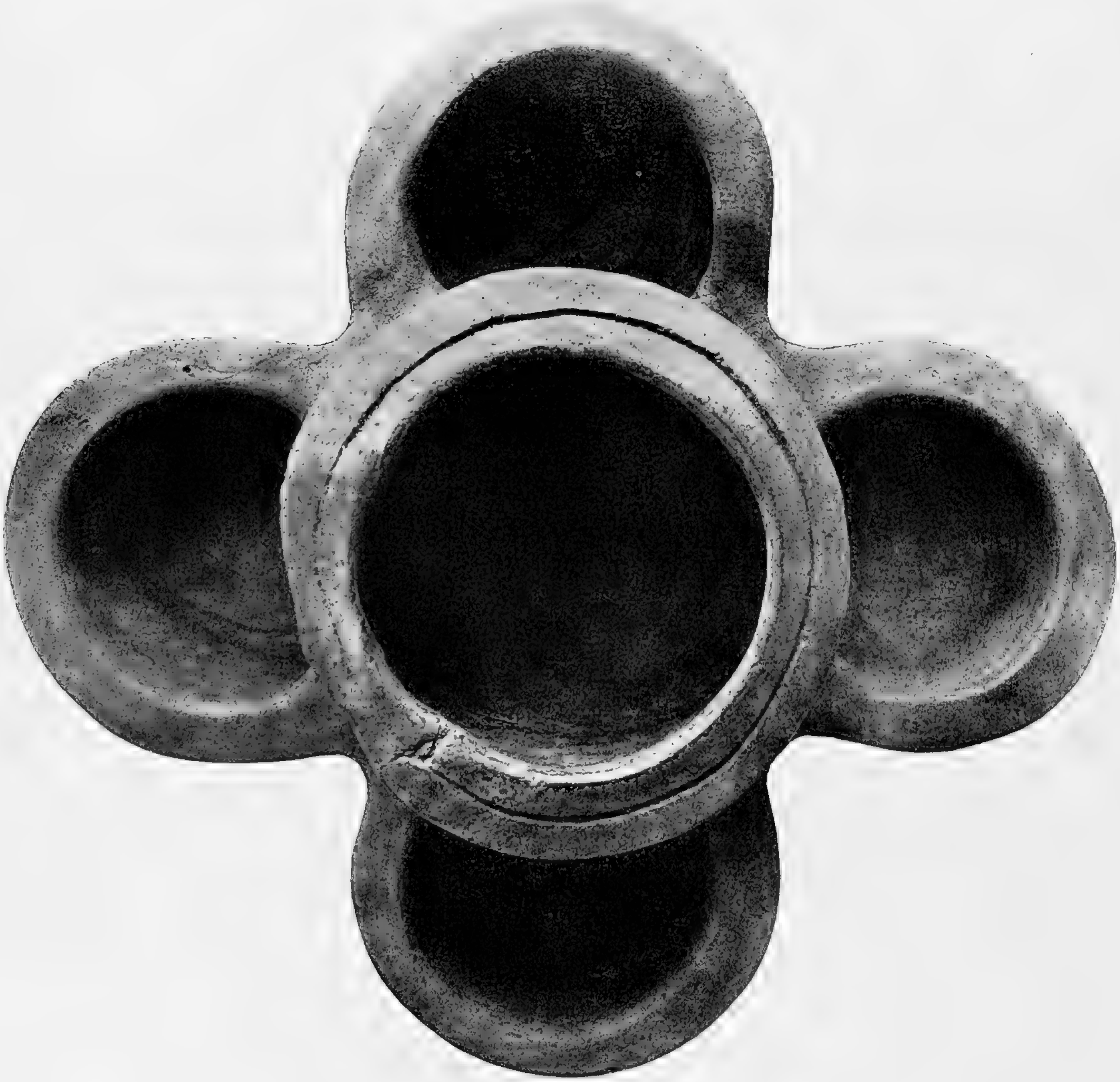


FIG. 268.—Vessel No. 27. Hall mound. (About five-sixths size.)

bill of one, missing when found, has been restored. In the heads, which are hollow, are small objects which rattle when shaken.

FIG. 269.—Vessel No. 30. Hall mound. (Five-sixths size.)

The lower part of a vessel, from which certain parts were missing, badly broken, has been cemented together and proves to have belonged to a vessel in all probability similar to No. 13 from this mound. Around this fragment winds a rattlesnake in

relief whose body twists twice upon itself. Restored portions of the serpent are shown in broken lines (diagram, Fig. 282).

An effigy of the human head, in relief, covered with crimson paint, which has projected from the rim of a vessel, was found alone in the mound in the sand near the surface. No fragments were in association nor was any part of a vessel found later, from which it seemed that this head might have come. This fact is much to be regretted as the modelling of the head is excellent (Fig. 283). A part of one cheek and a portion of the nose received blows from a spade.

Fig. 271.—Vessel No. 39. Hall mound. (Half size.)

Fig. 270.—Vessel No. 35. Hall mound. (Four-fifths size.)

Fig. 272.—Vessel No. 42. Hall mound. (Half size.)

FIG. 273.—Vessel No. 53. Hall mound. (Half size.)

FIG. 274.—Vessel No. 63. Hall mound. (Five-sixths size.)

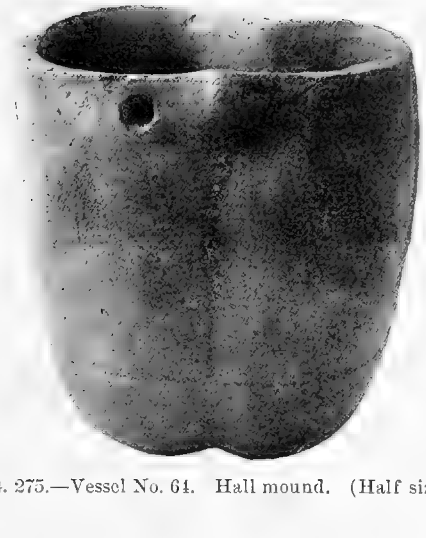


FIG. 275.—Vessel No. 64. Hall mound. (Half size.)

FIG. 276.—Vessel No. 65. Hall mound. (Two-fifths size.)

FIG. 277.—Handle of vessel. Hall mound. (About full size.)

FIG. 278.—Handle of vessel. Hall mound. (About two-thirds size.)

FIG. 279.—Handle of vessel. Hall mound. (About two-thirds size.)

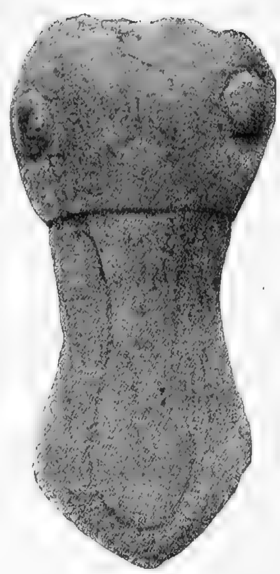


FIG. 280.—Handle of vessel. Hall mound. (Three-fourths size.)

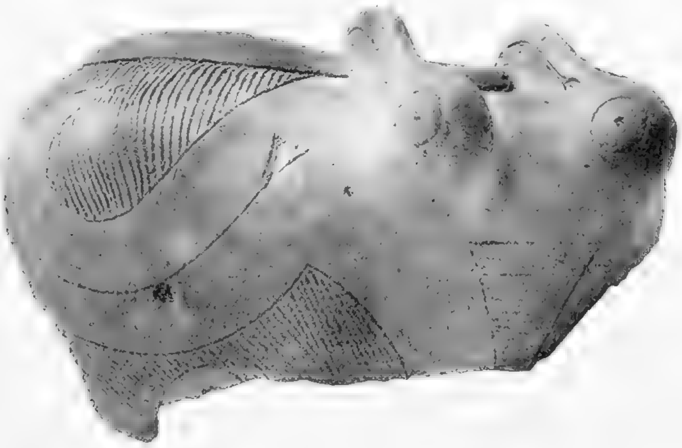


FIG. 281.—Sherd. Hall mound. (Half size.)

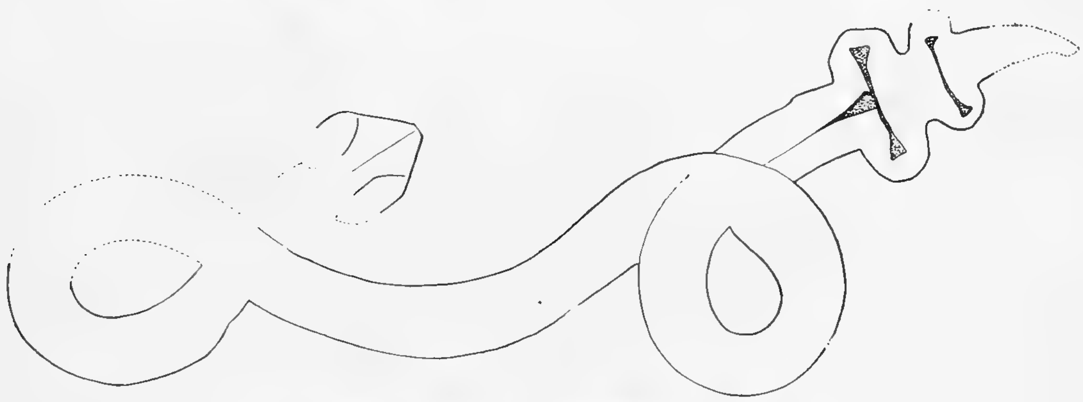


FIG. 282.—Rattlesnake on sherd. Hall mound. (One-third size.)

FIG. 283.—Handle of vessel. Hall mound. (Full size.)

Mound at Panacea Springs, Wakulla County.

This mound, in full view of the landing at the Springs, has a height of 4 feet and a basal diameter of 75 feet, approximately. It had been badly dug into before our visit.

It was examined by us with permission of Mr. Hall, owner of the large mound in the neighborhood.

Many trenches showed the mound to have been domiciliary in character. Except at one place, where, for a considerable area and depth, it was red from the action of a large and long-continued fire, the material of the mound was black, but not of the same character as the dark sand found with mortuary deposits in other mounds, this material being probably from low-lying ground nearby.

Mound near Spring Creek, Wakulla County.

Spring creek runs into Oyster bay, a part of Apalachee bay. The landing on Spring creek is where the great springs, which give the creek its name, pour into it.

This mound, in hammock, on property of Mr. N. R. Walker of Crawfordville, Fla., is somewhat over one mile in a northeasterly direction from the landing at the springs in Spring creek.

The mound, in the form of a ridge, slopes gently upward from E. to W., attaining its greatest height, 8 feet, near the western end, after which the ascent is comparatively abrupt. The diameter of base, longitudinally, is 104 feet; transversely it is 68 feet. The mound, which was seemingly intact, had various deep depressions along its margin, whence sand had come for use in its construction.

Twenty-five men digging two days, first went through marginal parts without result of interest, and then gridironed the mound with trenches in all directions.

No general deposit of earthenware was met with and only nine burials were encountered. It was clear to us that many interments must have disappeared from the mound through decay since so few were met with, and also because a number of objects were found unassociated with human remains, but lying in pockets of dark-colored sand where presumably bones had been. Such objects included: an elongated, pear-shaped pendant; mica in a number of places, some sheets rudely given the outline of lanceheads; half of a gorget; two pendants and part of one, lying together; a slab of fossilized wood; and the usual quota of bits of chert, hammer-stones, pebble-hammers and the like.

Near the margin was a rude, undecorated pot with the basal perforation. Parts of the rim were missing.

Near the surface, at different points, were two undecorated bowls, badly broken.

About 4 feet from the surface, at the western end, where the mound was highest, were two oblate spheroids of earthenware, evidently parts of the same vessel. The lower one, imperforate, is undecorated. The upper one has a neat, uniform design, the incised lines and punctate markings of which are filled with a yellow material as shown in Fig. 284. We cannot say to a certainty that the vessel was originally as

shown in the figure as the margins of the fracture had been carefully smoothed and offered no surface into which the parts could be fitted.

We shall give the burials in detail.

Burial No. 1.—A few crowns of human teeth, with two rude arrowheads; three bits of sandstone; one pebble, flat, oblong, with corners evidently artificially rounded; a rude smoking pipe of clay, of ordinary type.

Burial No. 2.—A few human teeth.

Burial No. 3.—Two small fragments of bone with two sheet-copper earplugs having central bosses in concave spaces. The reader will recall that with earplugs found by us in the mound at Huckleberry Landing were discs of pottery which, going back of the lobes of the ears, held the copper discs in place. Presumably discs answering the same purpose as the pottery ones, in this case, had been made of wood.

FIG. 284.—Vessel of earthenware. Mound near Spring Creek. (Full size.)

Burial No. 4.—Fragments of bone, with crowns of human teeth. With these were: a pebble; a bit of sandstone; an arrowhead or knife, of chert; a small fragment of some implement or ornament.

Burial No. 5.—A few fragments of human bones, with a chip of chert; an arrowhead or knife, of chert; a small curved knife and a lancehead, of the same material; and one pebble.

Burial No. 6.—Traces of bone, with two decayed bits of shell, a pebble and part of a shell drinking cup.

Burial No. 7.—Fragments of bone, with a coarsely-made smoking pipe; the lower half of a "celt"; a fragment of shell; a much decayed shell gouge; a double-pointed implement made from the columella of a marine univalve.

Burial No. 8.—Traces of bones, with an unevenly made pendant of ordinary type.

Burial No. 9.—A few bits of bone, with a soapstone smoking pipe of the usual shape; a pebble; a shark's tooth of the present geological period.

Mound near the Mound Field, Wakulla County.

The mound, very symmetrical, was in hammock land on the border of cultivated ground known throughout the region as the Mound Field. The mound was about two miles in NE. direction from the landing on Spring creek, on property belonging to Mr. N. R. Walker, the owner of the Spring creek mound.

The mound had a height of about 9 feet above the surrounding level, though a measurement taken when the mound was in process of demolition, from the summit plateau to undisturbed sand at the base, gave an altitude of about 11 feet.

The outline of the base was circular, with a diameter of 61 feet. Across the the summit plateau was 15 feet. A graded way about 15 feet wide joined the mound on the west, making the slope less steep on that side than on the others. The length of the causeway before union with the margin of the mound was 18 feet.

There had been but little previous digging in the mound which, with the exception of a small portion under two great trees, was thoroughly leveled by us.

Burials were found in twenty one places only, all in the eastern half of the mound, and included the bunch, the single skull, and, on several occasions, two skulls lying side by side. All these burials but two were near the surface, and all were so badly decayed that no determination as to cranial flattening was possible. Two, from near the base, consisted of a bit of femur in one place and two decaying long-bones in another. As the mound throughout was composed of dark, rich, loamy sand and the undisturbed sand beneath was dark brown, we feared, in the early stages of the digging, that we might have passed over graves beneath the base, so few burials were met with. The comparative absence of burials in the body of the mound, however, and the fragmentary condition of those which were found, added to the fact that a great area of the base was dug through to sand unmistakably undisturbed, convinced us that burials were not being passed over. We believe that such burials as may not have been found in the mound and in graves below it, had disappeared through decay.

With the exception of a bit of femur which lay near a vessel of earthenware, perhaps belonging to a pottery deposit, no artifacts were found with the dead.

Four "celts" lay near the surface, singly, as did a lancehead of chert. There were also in the mound: a large, flat pebble used for smoothing; another flat pebble roughly chipped on two sides; mica in several places; and, together, a smoothing stone, a bit of sandstone and two rough chert arrowheads or knives.

Beginning in the eastern margin and extending to the center of the mound, along the base and just above it, was the usual deposit of earthenware.

In this deposit, fifty-eight vessels, all perforate but two or three, were noted, though many others, broken and scattered, must have escaped us. These vessels may be divided into five classes.

1.—Pots and bowls of ordinary form, mostly of moderate size or small, undecorated, the majority found broken or falling into bits on removal. This class outnumbered all the rest.

2.—Vessels of ordinary shape, with incised or punctate decoration, a small class

with roughly executed work of simple pattern. A sherd, however, of most excellent ware, equalling anything we have found to the westward, was met with by us, as was part of a bowl, bearing a duck's head in relief and a carefully executed symbolical design (Fig. 285).

3.—Vessels of fairly good ware, small, as a rule, with encircling bands of com-

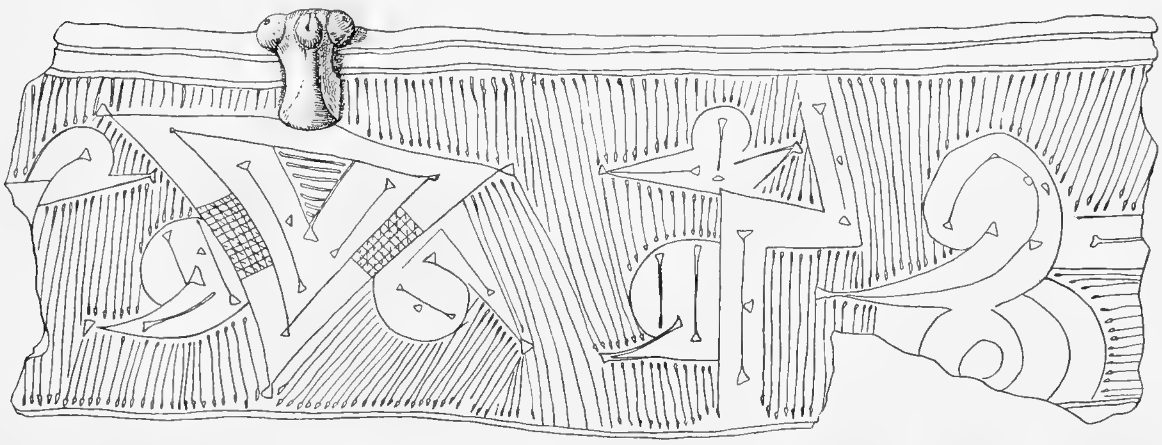


FIG. 285.—Sherd. Decoration. Mound near Mound Field. (Half size.)

FIG. 286.—Vessel No. 2. Mound near Mound Field. (Eight-ninths size.)

plicated stamp decoration below the rims. None of this class, ten in all, was found until that part of the base was reached which lay beneath the summit plateau. The decoration on most of these vessels had been executed with much greater care than was the case with the majority of those bearing this sort of decoration found by us

FIG. 287.—Vessel No. 7. Mound near Mound Field. (About two-thirds size.)

in other mounds and hence was more deeply impressed and lacked the confusion of design which arises from a double impression on parts of the decorated surface.

4.—This class was made up of vessels coated with crimson pigment, as a rule effigy-vessels, often of birds, and was of the ceremonial, or "freak," variety with basal holes made before the baking of the clay and with perforations of various shapes made at the same time through the body of the vessel. This ware, whose destination was understood at the time of manufacture, and consequently was but half baked and most inferior, was recovered by us in masses of fragments only, some past restoration.

FIG. 288.—Vessel No. 27. Mound near Mound Field. (Two-thirds size.)

5.—Two effigy-vessels, of better ware than that of which the ceremonial vessels were made, did not belong to that class, as holes knocked through the bases after baking and absence of perforations in the bodies, clearly testified. The aborigines had devoted more care to ware destined for their own use than to that turned out for the service of others in the "happy hunting grounds." Human nature is ever the same.

The following vessels merit particular description.

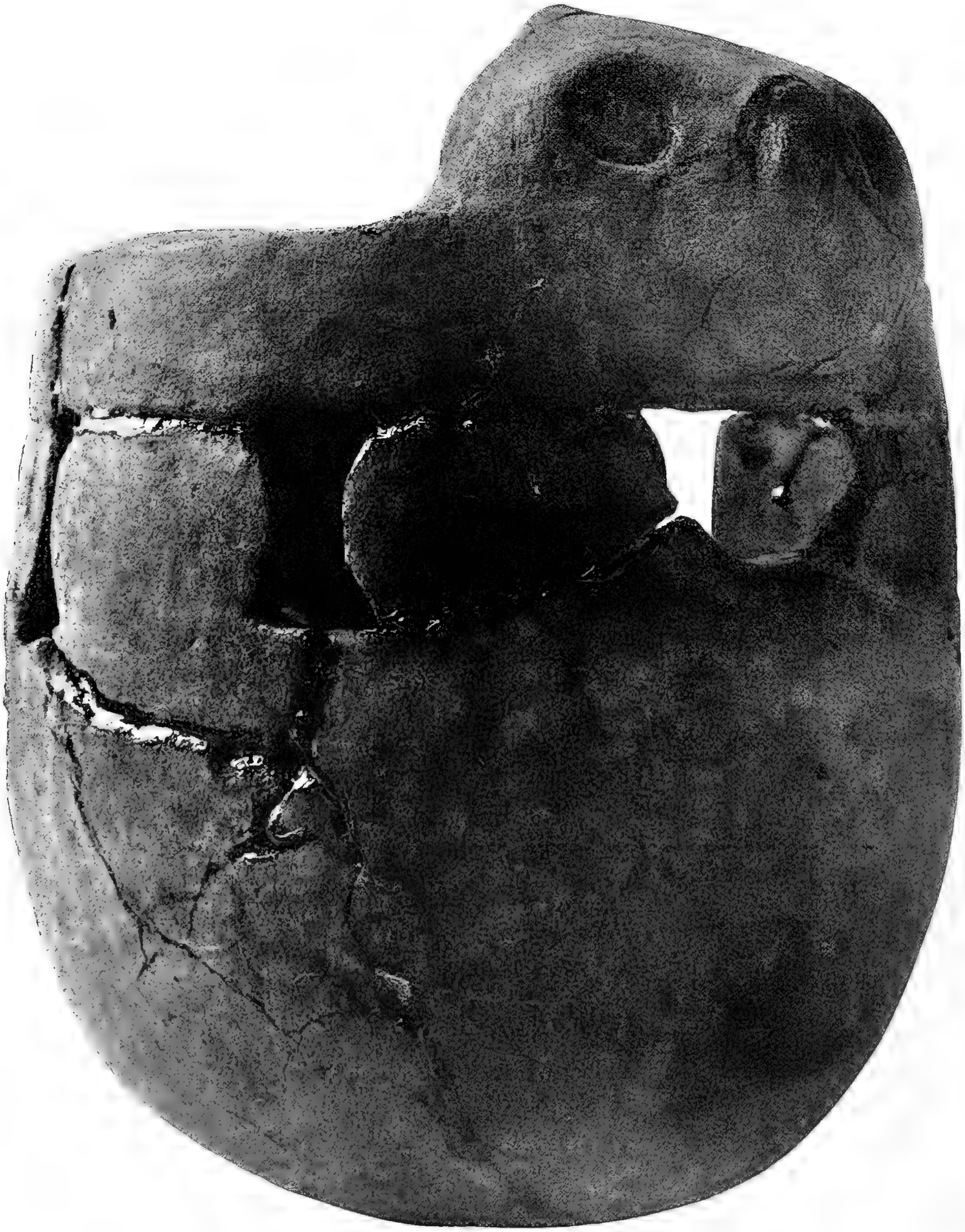


Fig. 289.—Vessel No. 29. Mound near Mound Field. (Five-sixths size.)

Vessel No. 2.—A vessel of about 2 quarts capacity, of solid ware, with decoration of lines of punctate markings, starting from the rim and converging around an undecorated, elliptical space at the base (Fig. 286). There are perforations for suspension, one at either side of the rim.

Vessel No. 7.—An interesting vessel of the ceremonial variety, covered with crimson pigment, found crushed to fragments. It has been cemented together, with restoration of the tail and a small part of the body (Fig. 287). Maximum diameter, 8.3 inches; height, 9.4 inches.

Fig. 290.—Vessel No. 31. Mound near Mound Field. (Five-sixths size.)

Vessel No. 10.—A bowl of about 1 quart capacity, a part of the rim missing, with decoration much resembling that on Vessel No. 5 from the Hall mound.

Vessel No. 16.—A pot having below the rim two parallel, encircling lines containing parallel, perpendicular lines, all very rudely executed.

Vessel No. 22.—Parts of a ceremonial vessel past restoration, as were a number of others in this mound.

Vessel No. 23.—A bowl of about 1 pint capacity covered with crimson paint inside and out.

Vessel No. 27.—A trilateral bowl with rounded corners, of about 6 quarts capacity, having a small bird-head looking inward. The decoration, which includes the bird-symbol, consists of the two designs shown in the half-tone (Fig. 288) thrice repeated, with but slight modifications.

Vessel No. 29.—A ceremonial vessel with rounded base in the center of which is the usual ready-made perforation. There are also openings around the body. Vertically from the rim rises the head of an owl, from which the beak and part of an ear have scaled away (Fig. 289).

Fig. 291.—Vessel No. 33. Mound near Mound Field. (Half size.)

Fig. 292.—Vessel No. 36. Mound near Mound Field. (About two-thirds size.)

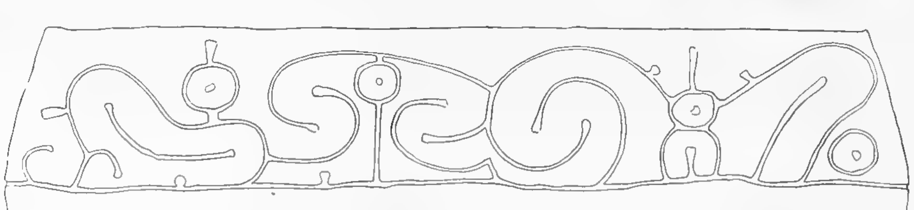


Fig. 293.—Vessel No. 36. Decoration. Mound near Mound Field. (One-third size.)

FIG. 294.—Vessel No. 37. Mound near Mound Field. (About two-thirds size.)

FIG. 295.—Vessel No. 39. Mound near Mound Field. (About four-fifths size.).

FIG. 296.—Vessel No. 42. Mound near Mound Field. (About five-sixths size.)

Vessel No. 30.—A bowl of about 1 quart capacity, decorated with crimson pigment, with bird-head at one end and conventional tail at the other. The wings are somewhat in relief and are farther indicated by incised lines and certain portions left free from the coloring of the rest of the vessel, showing the yellow ware. Part of the bill is missing. A hole has been knocked through the base.

Vessel No. 31.—Of about 2 quarts capacity, of solid ware but rather carelessly made, having eight *repoussé* ridges of irregular shapes and sizes around the body. The outside is covered with crimson pigment. A hole has been knocked through the base (Fig. 290).

Fig. 297.—Vessel No. 44. Mound near Mound Field. (Five-sixths size.)

Vessel No. 33.—Is of rather coarse ware, with a small bird seated on one side. There has been a certain amount of restoration (Fig. 291).

Vessel No. 36.—The upper part of a vessel of superior ware, shown in Fig. 292, heart-shaped in section, showing traces of crimson pigment, on the outside. The lower part of the vessel was vainly sought by us. The incised decoration is shown diagrammatically in Fig. 293.

Fig. 298.—Vessel No. 45. Mound near Mound Field. (Four-fifths size.)

Vessel No. 37.—This interesting vessel consists of a sphere flattened on one side, on which is placed an effigy of a horned owl. There is a perforation in the base, made before baking (Fig. 294). Height, 11.4 inches; maximum diameter, 10 inches.

Vessel No. 39.—A vessel of about 2 quarts capacity, with complicated stamp decoration around the neck (Fig. 295).

Vessel No. 42.—A vessel of good, solid ware, with complicated stamp decoration on the neck (Fig. 296).

Vessel No. 44.—An effigy-vessel of about 2 quarts capacity, representing an animal, probably a deer, judging from the horns, the cloven hoofs and the short tail. The hind-legs are *repoussé*, while the fore-legs, slightly *repoussé*, were made by the addition of material pressed upon the surface. There is crimson pigment inside and out. There are two holes for suspension and one knocked through the base. There has been a certain amount of restoration (Fig. 297).

Vessel No. 45.—An effigy-vessel representing a horned owl with head and tail protruding, and *repoussé* wings. The vessel has been decorated with crimson pigment, while on the wings are perpendicular, incised lines filled with light-colored

Fig. 299.—Vessel No. 45. Mound near Mound Field. (Four-fifths size.)

material (Figs. 298, 299). This vessel does not belong to the ready-made mortuary class as a hole has been broken through the base after completion of the vessel. Height, 8 inches; maximum width, 10.5 inches.

Vessel No. 47.—A bird-effigy vessel with incised decoration on wings, tail and back. The head is missing through an early fracture. This vessel was made with open base (Fig. 300).

Vessel No. 50.—A cup of about 1 pint capacity with clearly defined complicated stamp decoration (Fig. 301).

Fig. 300.—Vessel No. 47. Mound near Mound Field. (Eight-ninths size.)

FIG. 301.—Vessel No. 50. Mound near Mound Field. (Half size.)

FIG. 302.—Vessel No. 55. Mound near Mound Field. (One-third size.)

FIG. 303.—Vessel No. 56. Mound near Mound Field. (About eight-ninths size.)

Vessel No. 55.—A handsome bowl of excellent yellow ware, of about 3 gallons capacity, with encircling band of complicated stamp decoration, below the rim, which, of unusual shape, bears incised decoration (Fig. 302).

Vessel No. 56.—Has a distinct complicated stamp below the rim (Fig. 303).

There was in this mound part of a vessel of excellent ware carefully smoothed,

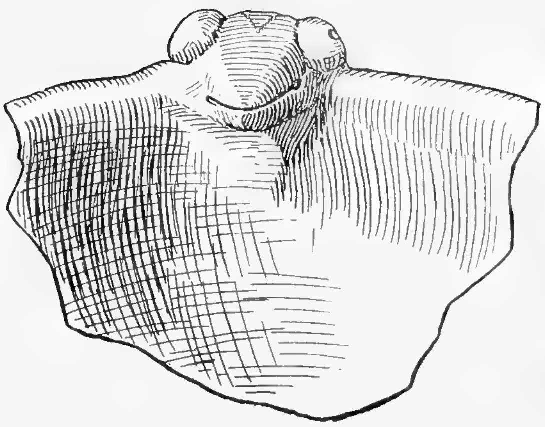


Fig. 304.—Sherd. Mound near Mound Field. (Full size.)

Fig. 305.—Sherd. Mound near Mound Field. (Three-fourths size.)

which, on the outside, has well executed incised decoration and the head of a duck in relief. A curious feature of this head is that a part of it, projecting inward, has been given a mouth, which, taken in conjunction with the rear portion of the eyes belonging to the head in front, gives the appearance of the head of an animal (Fig. 304).

A part of a ceremonial vessel, found alone, has a highly conventionalized bird's head (Fig. 305).

Mound near St. Marks, Wakulla County.

This mound is about 2 miles in a northeasterly direction from the light-house at the mouth of the St. Marks river, on ground formerly cultivated, the property of Mr. William Harrell, of St. Marks, Fla.

The mound is on an extensive ridge erroneously believed by many to be artificial. There are considerable shell deposits in the neighborhood. The mound, circular in outline, 3 feet high and 40 feet across the base, had been subjected to but little previous digging. It was totally demolished by us.

Though the sand was dryer than that usually met with in mounds of this section, yet human remains were found by us in the mound but once, a bunch in the eastern margin. Presumably a number of others had disappeared through decay.

In two places was much sand dyed with hematite.

Unassociated were two "celts" found separately, several sheets of mica, and a

few pebbles. Three shell drinking cups, all perforate, lay with the earthenware deposit.

At the eastern edge of the mound began a deposit of earthenware, the usual sherds, large fragments and whole vessels, placed here and there in black sand along the base, through an area about 8 feet across, and continuing well in toward the center. Among the sherds the check stamp was represented, and various forms of punctate impressions as well as carefully incised work. Neither on sherd nor on vessel did the complicated stamp appear, which probably accounts for the considerable number of interesting vessels present in so small a mound.

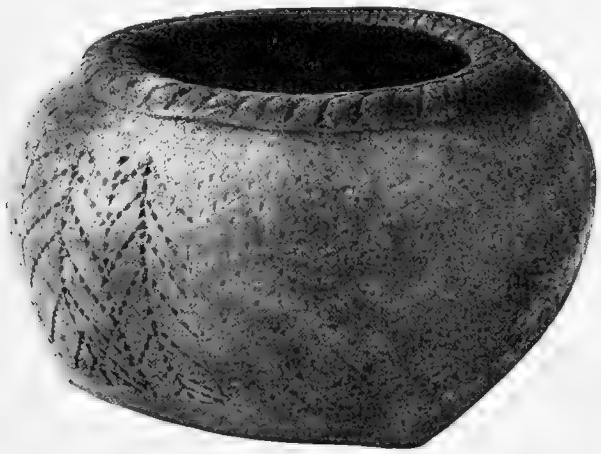


FIG. 306.—Vessel No. 2. Mound near St. Marks. (Half size.)

Vessel No. 2.—A quadrilateral vessel of about 1 quart capacity, with rounded corners. The decoration is made up of punctate lines, and incised lines on the rim. On each of two opposite sides of the opening is a hole for suspension (Fig. 306).

Vessel No. 3.—A bowl with incised and punctate decoration included in four designs around the upper part of the vessel, with undecorated spaces between. The larger are almost identical, as are the smaller. One of each is shown diagrammatically in Fig. 307. Maximum diameter, 11.5 inches; height, 8.4 inches.

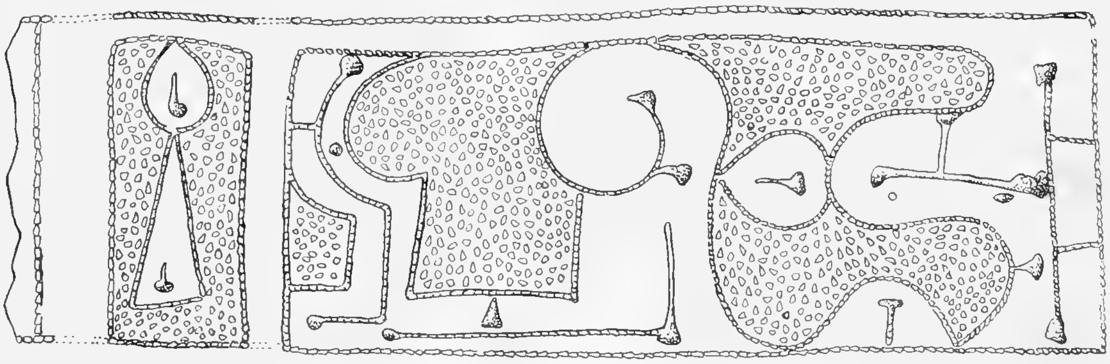


FIG. 307.—Vessel No. 3. Decoration. Mound near St. Marks. (Half size.)

Vessel No. 4.—A bowl of about 1 gallon capacity, of yellow ware, badly discolored, as were all vessels from this mound, with incised and punctate decoration almost identical on opposite sides (Fig. 308).

Vessel No. 6.—A four-lobed vessel with square aperture, shown in Fig. 309, having incised and punctate decoration almost identical on two opposite lobes, the remaining two being undecorated. There are holes for suspension.

FIG. 308.—Vessel No. 4. Mound near St. Marks. (Nine-tenths size.)

Vessel No. 7.—A bowl of about 3 quarts capacity, with inverted rim on which are two small protuberances probably indicating heads. There are two designs, almost similar, with a smaller one between. One of the larger and the small one are shown diagrammatically in Fig. 310.

Vessel No. 8.—A large undecorated bowl of heavy ware, with considerable thickening at the rim.

Vessel No. 9.—A vessel originally with five circular compartments, the central one above the rest. One compartment is missing. This vessel came from the western part of the mound, alone.

FIG. 309.—Vessel No. 6. Mound near St. Marks. (Eight-ninths size.)

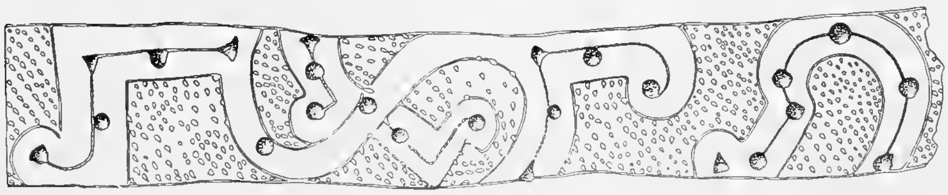


FIG. 310.—Vessel No. 7. Decoration. Mound near St. Marks. (One-third size.)

Vessel No. 10.—This four-sided vessel of about 3 pints capacity, of yellow ware, deeply stained, has incised and punctate decoration consisting of four designs, all alike, on the corners and, on two sides, similar designs, one of which is shown in the half-tone (Fig. 311). The decoration is deeply stained and obscured. On two sides are heads of birds in relief, presumably of the ibis. Formerly the pink ibis, now

FIG. 311.—Vessel No. 10. Mound near St. Marks. (About full size.)

almost exterminated in Florida, was well known there and must have contributed largely to the head-dress of the warriors. At Stowe island, where the Sisters' creek enters the St. Johns, near the mouth of the river, were found, in the spring of 1895, in the great shell-heap which was then being removed, human bones with large pink feathers in association, which probably belonged to the pink ibis. We inspected this discovery in person.

Vessel No. 11.—A four-lobed vessel of red ware, of about 2 quarts capacity. Two of these lobes have each three semicircular, parallel lines, while one has four. Under these lines, on one lobe, is additional decoration (Fig. 312).

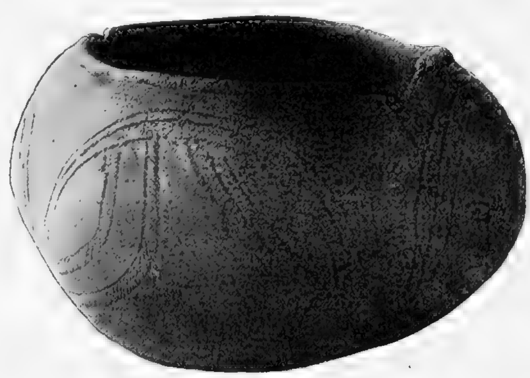


FIG. 312.—Vessel No. 11. Mound near St. Marks. (One-third size.)

Vessel No. 12.—A small undecorated bowl which came from the northern part of the mound, apart from the pottery deposit.

Vessel No. 13.—A quadrilateral bowl holding somewhat over 1 quart, having crimson pigment inside and out. The four corners of the rim project upward nearly one inch.

Vessel No. 14.—A four-lobed vessel found in fragments.

Vessels from this mound had the basal perforation.

Mound near the Aucilla River, Taylor County.

This mound, on property of Mr. B. F. Lewis, of Monticello, Florida, is in sight of the river, on the right hand side going up, about 2.5 miles from the mouth. A small stable of logs, with an enclosure in front, covers a part of the mound, beginning at the margin on the north side and extending well in to the summit plateau. The mound had been much worn by the trampling of animals, and probably by wash of water, as in time of freshet it is said to be the only place of refuge for stock in the vicinity. The height of the mound, at present, is 6.5 feet, though at one time it must have been considerably greater. The diameter of the base, 64 feet, has been

Fig. 313.—Handle. Mound near the Aucilla river. (Three-fourths size.)

Fig. 314. Vessel No. 1. Mound near the Aucilla river. (Full size.)

increased at the expense of the height. Over the surface of the mound, lying loose or half imbedded in it, are masses of lime rock, varying in size from that of a human head to irregular masses perhaps 1 foot by 2 feet by 1 foot. This lime rock is found off the shallow Florida coast, beginning east of St. Marks and in the small rivers which enter the Gulf, in that district.

As it was not our purpose to injure this place of refuge, our investigation was chiefly devoted to the eastern part of the mound, though other parts were accorded due attention.

The mound was curiously constructed, being made in the upper parts of clayey

sand, black and tenacious, probably from adjacent swamps. Below this, varying from 1 to 2 feet in thickness, was a stratum of clay more densely packed as it approached the center, until, under the summit plateau, the removal necessitated the use of a mattock or of a grubbing-hoe.

Throughout that part of the mound investigated by us, sometimes near the base, but usually not far from the surface, were scattered masses of lime rock similar to those we have described. These masses, as we shall see, often accompanied burials, but sometimes they lay unassociated with human remains.

During our work, seventeen burials, much decayed, were met with in various parts of the mound. Of these, fourteen burials were near the present surface of the mound and three flexed burials, unaccompanied by rocks, lay almost on the base. Of the superficial burials, eight were bunched, lying under masses of rock, and four were of the same class of burial, without rocks. One flexed burial lay beneath rocks, while two skulls, together, were surrounded by them.

FIG. 315.—Vessel No. 3. Mound near the Aucilla river. (Nine-tenths size.)

With the exception of several bits of chert, no artifacts lay directly with the dead. Somewhat apart from them, separately, were: one chert arrowhead or knife; a lancehead or dagger, of chert, 4.5 inches long; many chips of chert, scatterd here and there; several perforated shell drinking cups. These cups lay with the pottery deposit and probably were considered mortuary vessels.

At a short distance from the margin of the mound, in the eastern part as usual, began a small deposit of earthenware with the usual sherds and portions of vessels. The sherds, in the main, were of excellent quality. The check stamp was represented but once or twice. There were also the effigy-head of a dog (Fig. 313) and

one of an owl. Two large loop-shaped handles also were present. There was basal perforation in each entire vessel found by us.

The deposit lay along the base and numbered fourteen vessels or large parts of vessels. When our work was discontinued the deposit seemed to be ending and the fact that such vessels as might be found would lie in solid clay on which a mattock was used of necessity, rendered the ending of our work less of a disappointment.

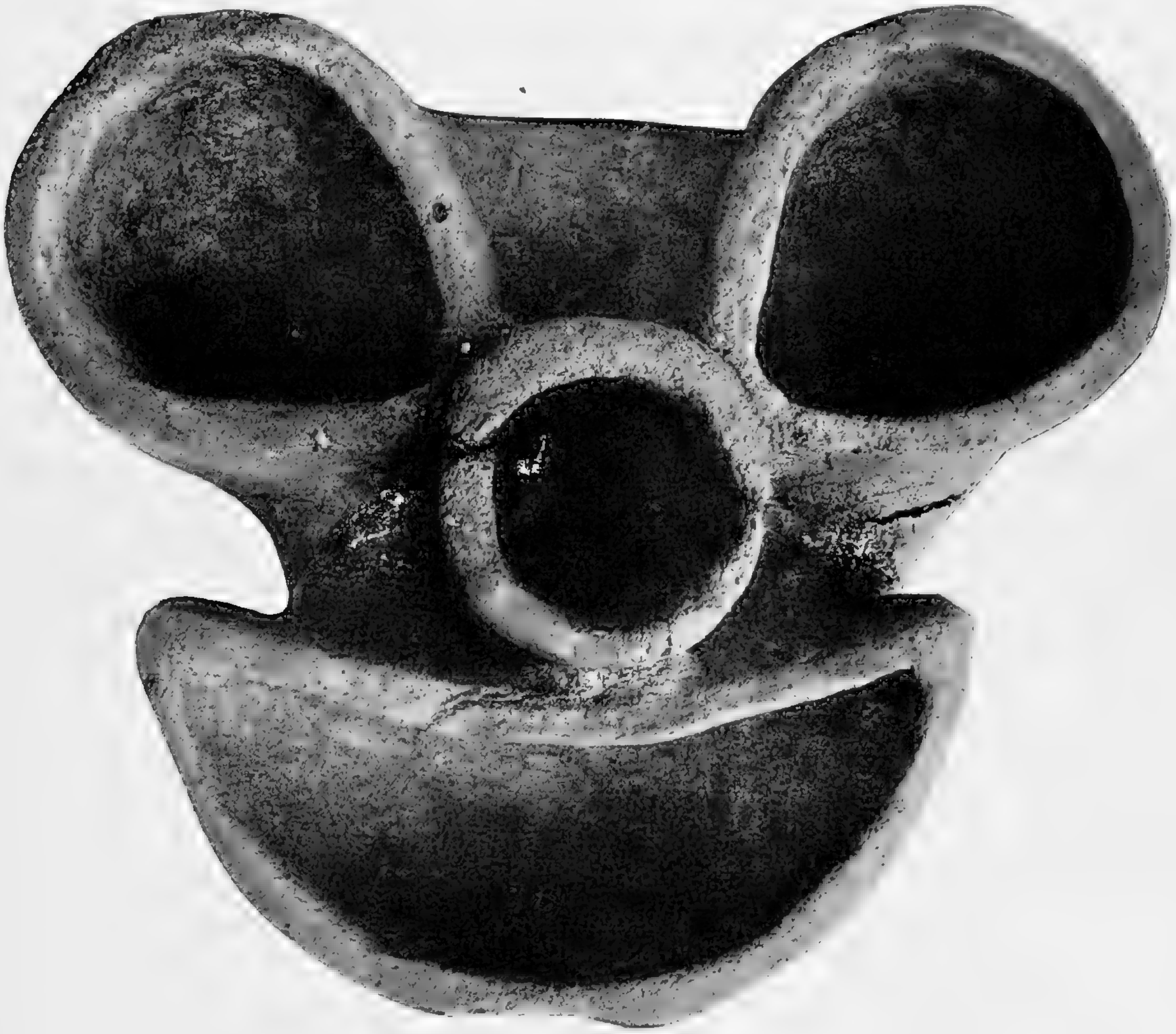


Fig. 316.—Vessel No. 7. Mound near the Aucilla river. (About full size.)

Vessel No. 1.—A neat little cup with octagonal rim and carefully executed incised and punctate decoration, one-half of which, shown in Fig. 314, is duplicated on the opposite side.

Vessel No. 2.—Has a band of complicated stamp decoration below the rim.

Vessel No. 3.—A bird-effigy vessel of excellent ware, showing traces of decoration with crimson paint. There is also an incised and punctate design representing a wing, on either side, and markings on the tail. The head represents that of a

FIG. 317.—Vessel No. 8. Mound near the Aucilla river. (Four-fifths size.)

turkey or a turkey-buzzard. In it are objects which rattle when shaken. There are two holes for suspension (Fig. 315). Diameter of body, 4.5 inches; height, 3.3 inches; length, 8.2 inches.

Vessel No. 5.—An undecorated bowl of yellow ware, of about 1 quart capacity. The base is flat.

Vessel No. 7.—A compartment vessel of inferior ware, with a small circular compartment near the center, surrounded by three others, two of which are oval in outline, the other, crescentic (Fig. 316). This vessel may represent a face with eyes, nose and mouth.

Vessel No. 8.—This impressive looking bird-effigy vessel, with head disproportionately small, and extended wings (Fig. 317) has incised and punctate decoration on the tail, shown diagrammatically in Fig. 318. Length, 11 inches; breadth, 12 inches; height, 8 inches;

Vessel No. 10.—This asymmetrical vessel of four compartments, has had three compartments in line, the central one square and raised somewhat above the other two, one of which has a curved margin. The other has a large portion missing (Fig. 319). The fourth compartment has the outline of a spread wing and would lead us to suppose that this was a compartment effigy-vessel, were a similar wing on the opposite side, but none is, or has been, there. Nevertheless, the vessel may be of the class we speak of, since the aborigines were not always consistent. In a low mound near Jacksonville, Florida,[1] we found a vessel with five compartments, which unquestionably represents a bird. The head, body, tail and wings are clearly outlined, yet the open wings point in opposite directions.

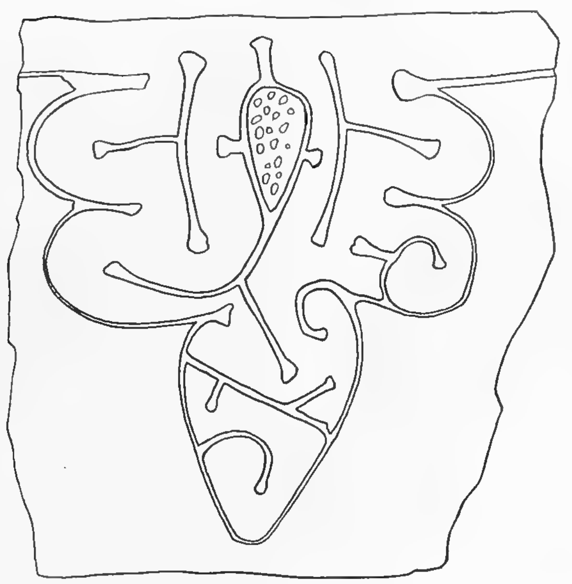


FIG. 318.—Vessel No. 8. Decoration of tail. Mound near the Aucilla river. (Half size.)

Vessel No. 11.—Somewhat over one-half of a vessel which had been made up of two hemispherical cups of solid ware, each of nearly one pint capacity. The part found by us was imperforate.

Vessel No. 14.—A large pot with complicated stamp decoration, badly broken. Immediately above it lay a mass of lime rock. We carefully examined the interior of this vessel for human remains, but found none. As a similar mass of rock lay beside the pot it is probable that the presence of the two masses was accidental.

[1] "Additional Mounds of Duval and of Clay Counties, Florida." Privately printed, Phila., 1896, pg. 13, Plates I and II.

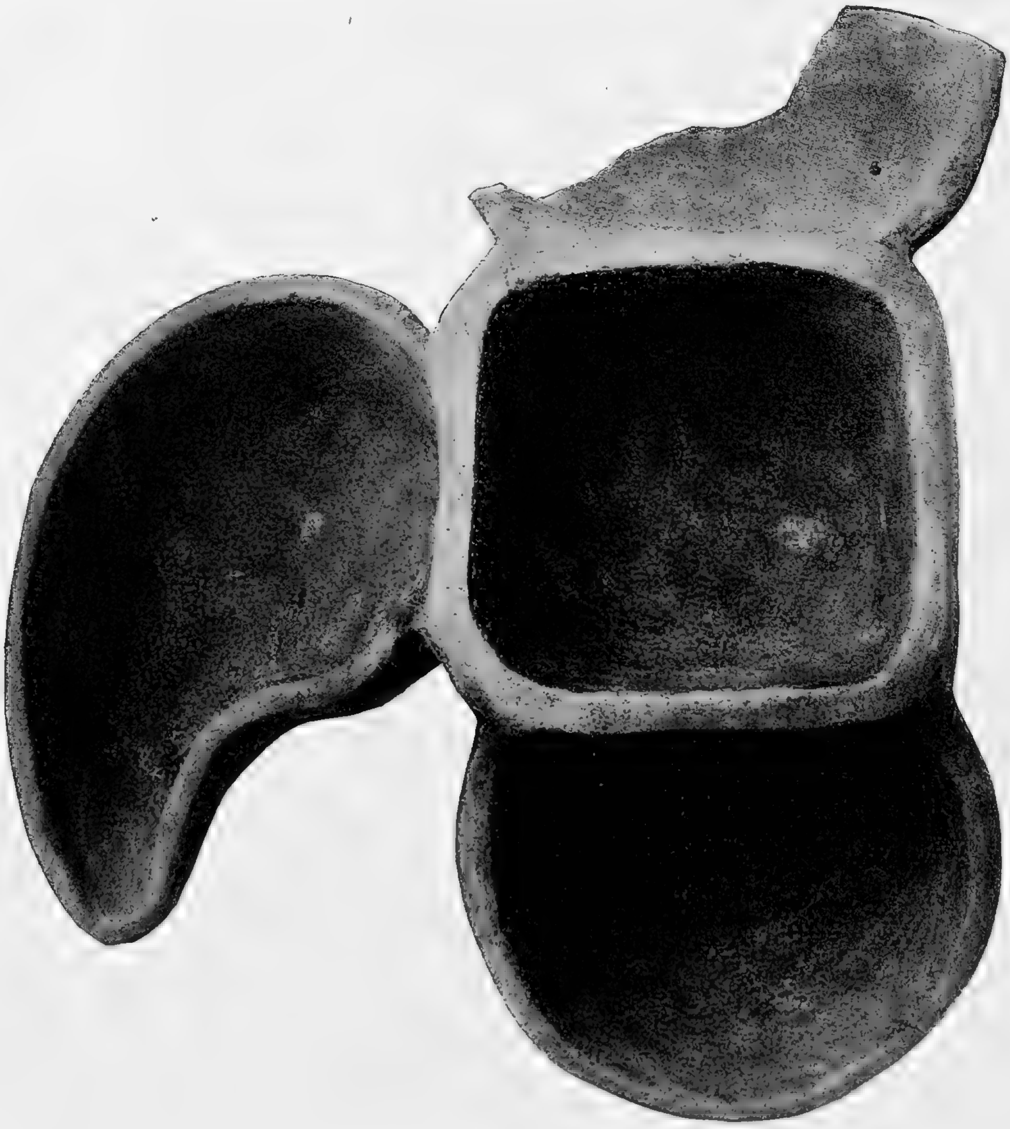


Fig. 319.—Vessel No. 10. Mound near the Aucilla river. (Three-fourths size.)

Mounds near the Econfenee River, Taylor County.

About 200 yards in the hammock, in a northerly direction from the "fish-camp," which is about 3 miles up the Econfenee river, on the left hand side, going up, is a mound 3.5 feet high and 50 feet across the base. This mound, the only place of refuge for stock, from the water of storm tides, was occupied by a family who had erected a small house on a portion of the western part and an out-door kitchen on part of the eastern side.

The mound was carefully trenched, with the exception of the part on which the house stood, digging being carried on within the kitchen.

The mound, of white sand, yielded nothing in the way of artifacts with the exception of a pebble-hammer, an arrowhead or knife and several bits of chert.

In the western slope was a burial consisting of a skull and, at a short distance, the lower part of a skeleton with the feet, however, turned toward the skull. As the skull was small and the other bones were small and delicate, it is likely all belonged to the same individual.

About 1 mile farther up the river and 50 yards in, from the left bank going up, approximately, on the edge of hammock land was a mound 2 feet high and 32 feet across the base. Thorough trenching yielded nothing beyond a few masses of lime rock in the center of the mound.

Mounds near the Warrior River, Taylor County. Mound A.

These mounds, on property belonging to the East Coast Lumber Co., Watertown, Fla., John Paul, Esq., President, were in dense undergrowth near a tract formerly under cultivation, known as the Pope Field. This field is about 2.5 miles in an easterly direction from the mouth of the Warrior river and 300 yards distant, approximately, from the south side of the stream.

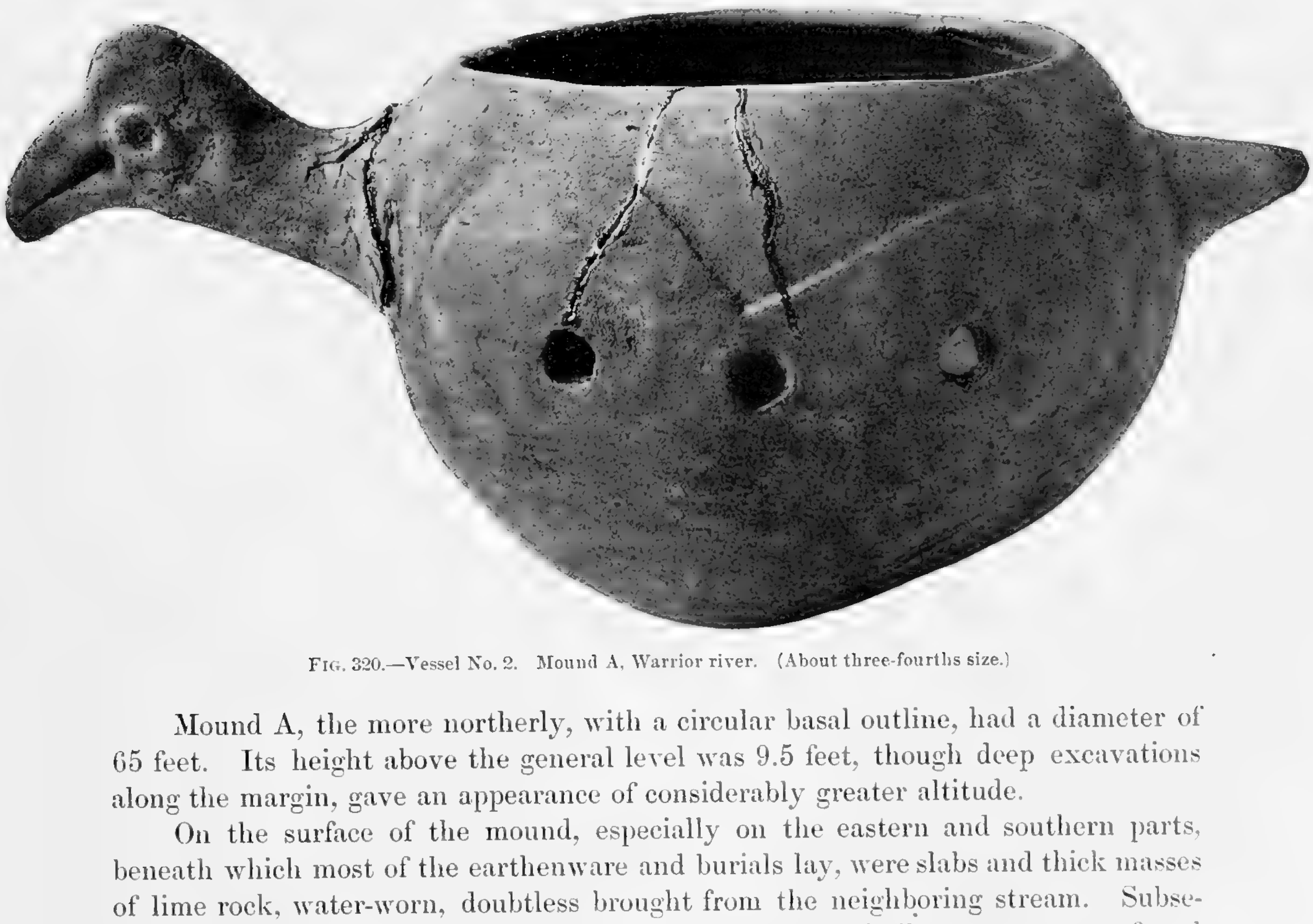


Fig. 320.—Vessel No. 2. Mound A, Warrior river. (About three-fourths size.)

Mound A, the more northerly, with a circular basal outline, had a diameter of 65 feet. Its height above the general level was 9.5 feet, though deep excavations along the margin, gave an appearance of considerably greater altitude.

On the surface of the mound, especially on the eastern and southern parts, beneath which most of the earthenware and burials lay, were slabs and thick masses of lime rock, water-worn, doubtless brought from the neighboring stream. Subsequently, when the mound was completely demolished, similar masses were found

FIG. 321.—Vessel No. 3. Mound A, Warrior river. (Eight-ninths size.)

here and there somewhat below the surface. These masses were often much larger than those described as being in the mound near the Aucilla river.

Mound A was of yellow sand except where pottery deposits lay, where it was much darker in color.

Human remains were found twenty-nine times and, as some of the burials were badly decayed, it is possible that others had entirely disappeared. As usual, there were present the bunch, the flexed burial and the lone skull. A few burials, falling in caved sand, did not afford data as to their form.

FIG. 322.—Vessel No. 4. Mound A, Warrior river. (About five-ninths size.)

Of the twenty-nine burials, many of which were on or near the base, nine lay immediately beneath the rocks, but in each case these burials were superficial, the least so being an interment 3.5 feet deep, almost in the middle of the summit plateau, around which had been many masses of rock, instead of the customary two or three. This burial had been disturbed by the only previous digging in the mound, a hole 4 by 2 by 6 feet deep, which had cut away part of the skeleton. In addition to this case, those under rocks, in this mound, were two bunched burials; two flexed burials; two skulls together; two skulls with long-bones, together; a lone skull; and bones which fell in caved sand.

No skulls were saved from this mound, but certain ones permitted determination as to the existence of cranial compression. None was evident.

With one burial was a "celt;" with another, a flat rectangular gorget, probably

of fine-grained, garnetiferous schist, 1.1 inches broad by 3 inches in length, having two perforations. An arrowhead or knife, of chert lay with a vessel of earthenware, and three perforated shell drinking cups were found in the line of the earthenware deposit. These, exclusive of earthenware, were the only artifacts noted by us in the mound, the usual hones, hammers and the like, not being met with.

Near the margin, on the north side, a vessel covered with crimson paint was found, crushed to bits.

Soon after the digging was begun, S. by E. in the mound were found a number of sherds, all of excellent ware and some with interesting and carefully executed incised decoration. No vessels, however, were found until a point had been reached about 10 feet in from the margin, where the sherds had been, when four vessels were found together. About 2.5 feet distant was a burial, which, however, we do not connect directly with the earthenware, since these vessels, as we have said, presumably belonged to the general deposit. This deposit lay on, or near, the base.

After these four vessels, for a period, none was met with, but later, as the digging progressed, others were encountered in ones and twos until the central portion of the mound was reached where were a considerable number, singly, here and there.

While the vessels in this mound were all of superior ware, with the exception, of course, of the ceremonial or ready-made mortuary ones, where excellence of material is not looked for, a point was markedly noticeable in this mound, as it had been in nearly all others of this district, namely, that the best and most interesting vessels are found among the first, and, therefore, must have been placed on the outskirts of the general deposit. Almost invariably, undecorated vessels or vessels bearing the complicated stamp, lie thickest toward the center, while interesting pieces, which called for care and individuality in execution, are found among the first when the pottery deposit is reached.

Twenty-four vessels came from this mound, of which the following offer features of interest. All not otherwise described have the basal perforation.

Vessel No. 1.—A flattened hemispherical vessel, badly crushed, with crimson paint for its only decoration.

Vessel No. 2.—An interesting bowl having the extended head of a vulture with a conventional tail, opposite it and, on either side, a wing in relief. Curiously enough, this vessel, which is of the ready-made mortuary variety, is imperforate as to the base, but has three round holes on either side of the body (Fig. 320). Maximum diameter, 12.5 inches; height, 5.5 inches.

Vessel No. 3.—A human-effigy vessel, found broken into fragments, with portions missing. There are two small holes front and two back for suspension and a hole knocked through the bottom of one leg. Part of the face, with the nose, has been restored (Fig. 321). Height, 11 inches; width, 6.7 inches; thickness, 4.3 inches.

Vessel No. 4.—A bird-effigy vessel of the ceremonial variety, with head thrust forward, and a conventional tail. The wings, which are in relief, have three perforations made before baking and there is also a basal perforation made at the same time.

A portion of the beak is missing owing to the scaling off of small fragments, a frequent occurrence in vessels of this inferior, mortuary ware (Fig. 322). Diameter of body, 8 inches; height, 6.5 inches.

FIG. 323.—Vessel No. 8. Mound A, Warrior river. (Two-thirds size.)

Vessel No. 5.—A vase with pinched decoration around the neck.

Vessel No. 7.—A vessel of yellow ware, somewhat stained, so exactly resembling a gourd that a countryman visiting the mound, believed it to be one containing water for the men.

Vessel No. 8.—A vessel of thick ware, decorated with crimson paint on the upper portion, is surrounded by seven projections. Above these are four designs, all similar, each including a vertical bird symbol. These designs are connected by

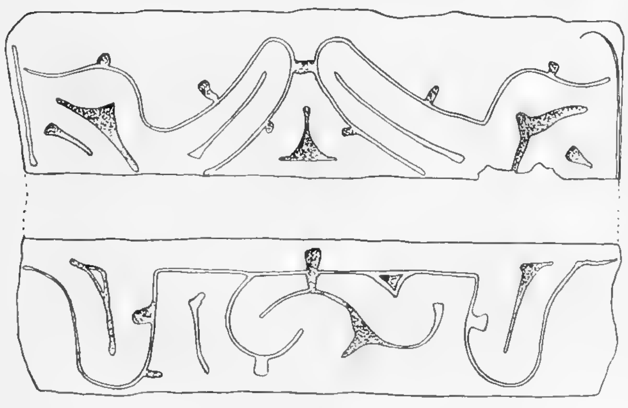


FIG. 324.—Vessel No. 13. Decoration. Mound A, Warrior river. (Half size.)

FIG. 325.—Vessel No. 20. Mound A, Warrior river. (Two-fifths size.)

FIG. 326.—Vessel No. 22. Mound A, Warrior river. (Full size.)

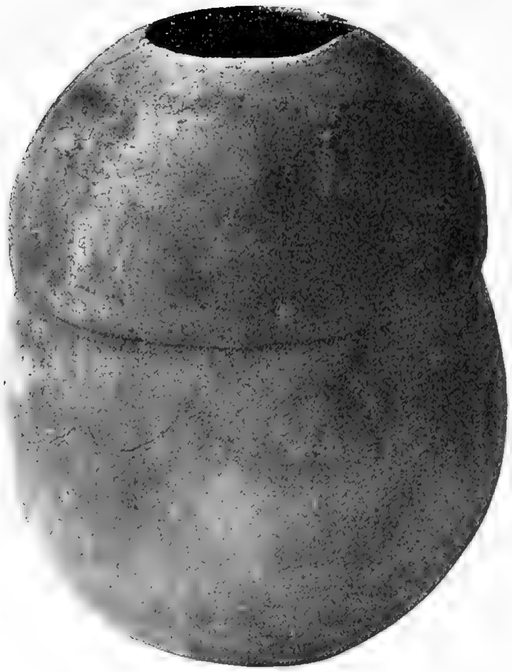


FIG. 327.—Vessel No. 23 Mound A, Warrior river. (Half size.)

FIG. 328.—Handle. Mound A, Warrior river. (About two-thirds size.)

punctate markings (Fig. 323). This vessel, whose capacity is about 1 quart, is a highly conventionalized life-form, the knobs representing projecting organs.

Vessel No. 9.—A large pot with complicated stamp decoration, in fragments.

Vessel No. 10.—A small imperforate vessel with quadrilateral body, flat base and round upright neck encircled by a complicated stamp decoration.

Fig. 329.—Sherd. Mound A, Warrior river. (Two-thirds size.)

Vessel No. 11.—An undecorated gourd-shaped vessel of yellow ware, with a small perforation in the side in addition to the usual one in the base. This vessel, of unusual size to find intact, was recovered by us from the mound without injury. Maximum diameter, 14.8 inches; height, 14.3 inches.

Vessel No. 12.—A large pot bearing the complicated stamp, found in fragments.

Vessel No. 13.—A bowl of about 1 quart capacity, with a rim turned inward and upward, bearing incised animal symbols, including the fore-legs and hind-legs, as shown diagrammatically in Fig. 324, where the distance between the two designs on the vessel is ignored.

Vessel No. 14.—A small undecorated vessel, lenticular in longitudinal section.

Vessel No. 18.—A much flattened sphere with high neck, slightly flaring, around which is complicated stamp decoration.

Vessel No. 20.—A pot bearing a clearly impressed complicated stamp (Fig. 325).

Vessel No. 22.—A handsome vessel of excellent ware, highly polished, of somewhat less than 1 quart capacity. The decoration, raised and incised, may be highly conventionalized fore-legs and hind-legs (Fig. 326).

Vessel No. 23.—Is undecorated, imperforate, of about 1 quart capacity (Fig. 327).

Fig. 328 shows an animal head which has served as a handle for a vessel.

A complicated stamp decoration is given in Fig. 329.

Mounds near the Warrior River, Taylor County. Mound B.

This mound, in thick hammock, about 200 yards in a southerly direction from Mound A, was of irregular outline, with major and minor diameters of 76 feet and 54 feet, respectively. Its height was about 7 feet. There were great excavations in places around the margin, whence sand for the erection of the mound had come.

There had been no previous digging.

Owing to the marginal excavations to which we have referred, it was impossible to determine, from its appearance, just where the mound began, therefore twenty men were placed around it in a circle whose diameter exceeded that of the mound,

and trenches, each about 3 feet across, were continued in the direction of the center until the exact margin of the mound was located.

Contrary to the usual course of events in our work in this district, when the trenches had gone 2 or 3 feet into the mound, earthenware vessels were met with in the western and southern parts. These vessels were not accompanied by sherds and did not lie together in a deposit, but had been placed here and there, singly.

After this discovery, the trenches in the western half of the mound were joined and the total demolition of that part of the mound began.

Shortly after this junction of the trenches on the western side, the trenches in two-thirds of the eastern side were joined and continued until the mound was dug down.

Not until the trenches had gone a distance of 22 feet into the remaining third of the eastern part, was anything of interest met with, when the discovery of a vessel of earthenware, caused the union of the remaining trenches.

Soon after the first junction of the trenches, that is 2 or 3 feet in from the margin, burials were met with in the W., NW. and SW. outskirts of the mound and, later, in part of the eastern portion. While burials were met with here and there in the parts of the mound we have referred to, none was found in the remaining portion of the eastern part until the center of the mound had almost been reached.

In all, thirty-five burials were counted by us, the majority in small bunches, though solitary skulls were present and, rarely, two skulls together.

The flexed burial was not noted.

Neither in our field notes, where the burials are described one by one, nor in our amplified notes, always written immediately at the end of the investigation of the mound, do we find any reference to cranial compression in connection with the burials in this mound. Neither do we recall the discovery of any cranial flattening, and it is our belief that none was met with.

The sand in this mound was not discolored in any way. It was remarkably dry and caved readily. On the surface lay a single mass of lime rock, and in the mound were a few similar masses unassociated with burials, while twice only, burials lay beneath them. A few oyster-shells were with two other burials, but not in the way we have noted in places to the westward where masses of shells lay over bones.

With one burial was sand colored with hematite. Another burial lay near three vessels of earthenware, while mica and a pebble lay together with human remains.

Unassociated with human bones, together, were: four pebble-hammers; two flat pebbles; eight chips of chert; seven very rude arrowheads or knives, of the same material, three with points missing.

In another place where no bones were met with, though they may have disappeared through decay, were: a long flake, intended for a knife; an arrowhead or knife; another with the point missing; a small knife with curved edge. All these were of chert.

There were also in the mound: a large tooth of a fossil shark, showing no

mark of use in a handle; a large slab of ferruginous sand-stone; a lancehead of chert, 4 inches long and nearly 3 inches in maximum diameter, so rudely made that it would seem that mortuary deposits of inferior quality, made expressly for the dead, were not confined to vessels of earthenware.

Fig. 330.—Object of kaolin. Mound B, Warrior river. (About five-sevenths size.)

We have referred to a curious object of impure kaolin, found by us in the mound near Porter's bar. An object exactly similar in shape, carefully smoothed and enlarged at either end, about 9.5 inches long, was present in this mound. It, also, has suffered through the chipping off of portions, but not to the same extent as had the other (Fig. 330). As is the case with the other, traces of decoration in low relief are visible in places. This curious object, the second found, would seem to belong to a class perhaps of ceremonial batons. It is certain that a material so soft could not have been chosen for any practical use. Dr. H. F. Keller, to whom a part of the object was submitted for analysis, writes: "It consists of an intimate mixture of kaolin and finely-divided silica. The constituents are silica, alumina, oxide of iron, moisture, and traces of magnesia. A rough determination of the silica yielded 75%, which is 27% in excess over the amount present in pure kaolinite. The proportion of iron, too, is considerable. Under the lens the powdered substance appears quite homogeneous, but under higher powers it shows crystalline particles of two kinds, as well as dark specks."

There was also in the mound a rectangular mass, seemingly of clayey material, with rounded corners and a small groove at either end, about 6 inches long.

The earthenware in this mound did not lie in black sand, nor was there any general mortuary deposit, four vessels together in the southern margin being the nearest approach to one.

The ware, in marked contrast to that of the neighboring mound, was of poor quality and undecorated or bore the complicated stamp, as a rule. Incised decoration was encountered in three instances only, among the forty vessels noted by us, and in each case the work was unambitious and careless in execution.

The features of the earthenware in this mound were the large number of vessels with inturned rims and, consequently, comparatively small openings; and the unusual percentage of imperforate bases present, no less than 22 of these being included among the 42 vessels met with, and others badly broken, may have been imperforate also. Marginal vessels, as a rule, were perforate; of the first twelve vessels found, but one had the base intact. Most of these vessels came from the south and southeastern margins and perhaps were in place of a general deposit.

In this mound were no ceremonial vessels and, consequently, no basal perforation made previous to baking.

FIG. 331.—Vessel No. 4. Mound B, Warrior river. (Nine-tenths size.)

The following vessels are worthy of particular notice, those omitted being, as a rule, undecorated or bearing the complicated stamp in well known patterns.

Vessel No. 4.—Of about 1 pint capacity, with horizontal ears extending one from either side, beneath the rim. There is roughly incised decoration (Fig. 331). There is a basal perforation.

Vessel No. 5.—Of red ware, undecorated, with cylindrical body, rounded base and upper end constricted to form a small opening. This vessel, of about 1 quart capacity, fell into many pieces on removal.

Vessel No. 7.—Has the base and lower part of the body knocked out, in performance of the customary mutilation. This vessel, of about 3 pints capacity, has

the upper part turning inward and upward, about 1.5 inches, forming an aperture of about 2.5 inches (Fig. 332). The decoration, incised, the only example in the mound not subsidiary, is shown diagrammatically in Fig. 333.

Vessel No. 11.—A small bowl with flat base and clearly defined complicated stamp decoration (Fig. 334).

Vessel No. 14.—Considerable parts of a bowl of yellow ware, in fragments,

FIG. 332.—Vessel No. 7. Mound B, Warrior river. (Five-sixths size.)

having as decoration lines, triangles and circular markings, all in black pigment. This is the first example, we believe, of the use of black paint on earthenware found during our mound work, though, as the reader is doubtless aware, this form of decoration was in vogue among the aborigines in various parts of the country. Portions of this vessel were found scattered over an area of about 4 feet by 12 feet, showing that the individual having in charge the immolation of the vessel, went at the work with a will.

Vessel No. 16.—Of about 1 gallon capacity, undecorated and rounded at either end (Fig. 335).

Vessel No. 17.— A most interesting vessel of heavy red ware, with five compartments, consisting of a circular, central compartment raised above the level of the rest, with two truncated, triangular ones on opposite sides and two triangular ones on the remaining sides. Projecting from the end of one compartment is the head of a bird, decorated on the upper side only. The opposite end, the tail, unfortunately, is missing. On the body of the vessel the bird-symbol appears in many places (Fig. 336). This vessel, the central part of which was filled with charcoal, and a compartment on either side, with sand blackened by fire, would seem to be a connecting link between the compartment vessel and the bird-effigy vessel, the other being where the bird is given in outline of the compartments only. Diameter across wings, 10.2 inches; height, 2.5 inches.

FIG. 333.—Vessel No. 7. Decoration. Mound B, Warrior river. (Half size.)

FIG. 334.—Vessel No. 11. Mound B, Warrior river. (Half size.)

Vessel No. 20.—A neat, imperforate, undecorated bowl of less than 1 pint capacity, greatly thickened at the rim.

Vessel No. 21.—Red ware, imperforate, with the rim inturned somewhat. On the upper part are three encircling lines made up of upright punctate impressions. The capacity is about 1 quart.

Vessel No. 24.—A small pot, imperforate, with rude complicated stamp, and three feet on the base instead of four, the usual number in this part of Florida.

Vessel No. 26.—A small, undecorated, imperforate bowl, elliptical in longitudinal section.

FIG. 335.—Vessel No. 16. Mound B, Warrior river. (One-third size.)

Fig. 336.—Vessel No. 17. Mound B, Warrior river. (About seven-tenths size.)

Vessel No. 31.—An imitation of a gourd, which is made complete by the yellow color of the ware and a rusty appearance imparted by age, seen in places on the vessel and often met with on the natural gourd. The capacity is about 2 quarts (Fig. 337).

Vessel No. 38.—An imperforate, undecorated vessel of about 2 quarts capacity, scaphoid in shape. There are traces of crimson pigment exteriorly.

FIG. 337.—Vessel No. 31. Mound B, Warrior river. (Four-fifths size.)

A point of interest impressing itself on us in connection with Mounds A and B, near the Warrior river, is that here, at Alligator Harbor and near Spring creek, two mounds of considerable size are at each of these places in close proximity one to the other. In each of these pairs of mounds one was symmetrical, while the other was in the form of a ridge. From the symmetrical mound, in each case, came ware much superior to that found in the asymmetrical ridge.

MOUND NEAR STEINHATCHEE RIVER, LAFAYETTE COUNTY.

The mound, in thick scrub, is about one-quarter of a mile in a SE. direction from Rock Landing, which is about 4 miles above the mouth of the river. The height is 4.5 feet; the diameter of base, 62 feet.

Extensive digging was first done around the margin, showing the sand to be bright yellow with no trace of discoloration. One sherd only was met with.

Next the mound was dug centrally, with four large trenches radiating to the margin. One sherd was found and sand discolored by hematite, in one place. In three places, rather superficially, were bits of badly decayed bones.

Mound near Goodson's Fishcamp, Lafayette County.

The site of the fishcamp is on a small water-way extending in from the Gulf, about 2 miles in a SE. direction from the mouth of the Steinhatchee river.

The mound, in pine woods, on the edge of the sawgrass marsh, on property of the East Coast Lumber Company, was much spread by trampling of cattle. A few fragments of human bone lay on the surface. Its height was 4 feet; its basal diameter, 66 feet. Apparently, there had been no previous digging.

The mound was trenched in every direction by us and dug marginally and centrally. The sand was bright yellow with no sign of that darkening which so often accompanies an earthenware deposit. A single skull was found 1 foot below the surface, and a small bunched burial elsewhere at about the same depth.

A large stone hatchet lay 6 inches beneath the surface.

A globular vessel of inferior ware, with a perforation knocked through the base, having faint punctate decoration below the rim, lay alone about 6 inches down.

A carefully made discoidal stone of quartzite, with a small concavity in the base which is somewhat broader than the upper part, lay unassociated. This discoidal stone is of interest, in that it is the first found by us in peninsular Florida, in which this mound is, though we have met with the type in abundance in Georgia to the eastward, and in Alabama to the westward.

Mound near Bear Hammock, Lafayette County.

This mound, in pine woods, on the eastern edge of Bear Hammock, about 3 miles in a SE. direction from the mouth of the Steinhatchee river, on the property of the East Coast Lumber Company, was intact at the time of our visit. Its height was 4.5 feet; its basal diameter, 52 feet.

Thorough trenching showed the mound to be of bright yellow sand. No burial or artifact was met with.

Mound near Murphy Landing, Lafayette County.

Murphy Landing is on the coast about 2 miles above Horseshoe Point.

The mound, in a field formerly under cultivation, the property of the East Coast Lumber Company, about one-quarter mile from the Gulf, had a height of 4 feet 3 inches; a basal diameter of 52 feet. The outline was circular. We heard of previous digging in the mound, but as we saw no trace of it, presumably, it was insignificant.

The mound, which was of light sand with a dark streak at the base, was completely demolished by us.

Human remains were met with at thirty-six places, and included the lone skull, the bunch and the flexed burial. No skull was in a condition to keep, but a number

showed that no cranial compression had been practised. Burials were first met with in the eastern margin, but, later, were encountered throughout the mound. In the eastern part of the mound, after a number of single burials had been met with, a layer of bones was encountered extending in, toward the center, a considerable distance. This deposit, which was counted as a single burial, had with it much sand dyed with hematite.

In the western part of the mound, about midway between the margin and the center, began a thin layer of oyster-shells on which lay several burials. Two burials lay with oyster-shells, locally. Two others had "celts" nearby, while with two more were a few small shell beads.

Unassociated, was a nodule of chert, the shape of a finger slightly bent and about its length, with double its diameter. At one end is a certain amount of chipping, seemingly preliminary to making a cutting tool. There were also in the mound an arrowhead of chert and a ball of lime rock about 1 inch in diameter.

Earthenware was represented in the mound by a few sherds of markedly inferior ware, some having a slight admixture of sand in the clay. In the way of decoration sherds bore the small check stamp, a rude punctate marking and, in one case, a pinched design. A small, undecorated bowl, with a hole knocked through the bottom, fell with caved sand.

Mounds near Horseshoe Point, Lafayette County.

These mounds, in thick hammock, on property of the East Coast Lumber Company, lie near the edge of the marsh, somewhat to the north of Horseshoe Point. A visitor would find it to his advantage to follow a road about two miles in a northeasterly direction from the landing.

The principal mounds, three in number, lie in sight of one another and are near considerable shell deposits. A large fresh-water pond is nearby and a natural waterway to the Gulf, doubtless available for canoes, ends in sight of the mounds, which are surrounded now, as no doubt they were in former times, by hammock-trees, including tall palmettoes and magnolias.

The mound nearest the Gulf was built on the end of a shell-heap, a part of the mound extending over to the general level beyond. Its outline was circular; its diameter, 40 feet; its height above the shell-heap, 6 feet. A great trench had been dug from the SE. margin to the center. The remainder of the mound was practically demolished by us.

A number of burials were met with at various points in the mound. No flattening was apparent on the skulls, which, however, were not in a condition to save.

Mainly from the western side and from near the center, comparatively near the surface, were ten vessels of inferior ware, all found singly. None of these bore incised decoration, save one, which had two encircling lines. One sherd, however, of the few found in the mound, was of excellent ware and bore a carefully incised conventionalized bird's wing.

Vessel No. 1.—A vessel of about 3 quarts capacity, shown in Fig. 338, with four projections, perhaps indicating a highly conventionalized life-form. The upper part of the body is painted crimson; the lower has the natural yellow color of the ware. Part of the base has been knocked out.

Vessel No. 2.—A bowl of about 2 quarts capacity, with three encircling lines of triangular punctate markings. There is a basal perforation.

Vessel No. 3.—A large undecorated vessel of yellow ware, modelled after a gourd, with a portion missing.

Vessel No. 4.—A vessel with oblate spherical body and high upright neck bearing a distinct complicated stamp (Fig. 339). The base is missing through mortuary mutilation.

Fig. 338.—Vessel No. 1. Mound near Horseshoe Point. (One-third size.)

Fig. 339.—Vessel No. 4. Mound near Horseshoe Point. (Half size.)

Fig. 340.—Vessel No. 6. Mound near Horseshoe Point. (Half size.)

Vessel No. 5.—Another large vessel modelled after a gourd, found in fragments.

Vessel No. 6.—A double vessel of yellow ware, also of the gourd pattern (Fig. 340). There is a basal perforation.

Fig. 341.—Vessel No. 10. Mound near Horseshoe Point. (Two-fifths size.)

Vessel No. 7.—A small, imperforate vessel, with rude, punctate decoration.

Vessel No. 8.—An undecorated, perforate bowl of about 6 quarts capacity, scaphoid in shape, with red paint inside and out.

Vessel No. 9.—Small, undecorated, with four-lobed body. There are two holes for suspension; also a basal perforation.

Vessel No. 10.—Of heavy ware, undecorated, of about 1 pint capacity. In form this vessel resembles an inverted acorn. There are two holes for suspension and a perforation in the base (Fig. 341).

The next mound was a ridge 80 feet long by 58 feet across. The maximum height was 6 feet. The highest portion was carefully trenched by us, yielding beside a number of burials, three "celts," two of which are of a chisel-form, and a small undecorated bowl with basal perforation.

The third mound, circular in outline, 3 feet 4 inches high, 54 feet across the base, furnished one broken arrowhead as the result of careful trenching. This mound was probably domiciliary.

Mound on Hog Island, Levy County.

Hog Island is a small key between the eastern and western passes into the Suwanee river.

The mound, but a short distance from the marsh, is in a dense mass of trees, bushes, and palmetto scrub. Its height is 9 feet 3 inches; its basal diameter, about 50 feet.

This mound seemed to be a shell-heap covered with from 12 to 18 inches of sand. A hole put in by a former digger, showed only shell, as did a large cavity caused by the fall of a great tree. Trenches put in by us reached shell almost immediately, and, after considerable digging in this material, the investigation of the mound was abandoned.

Mound on Pine Key, Levy County.

Pine Key, a small island, lies about one-quarter of a mile from a great shell-heap on the mainland. This shell-heap, visible at a long distance from the Gulf, the northernmost of the great shell-heaps of the west coast, lies about 5 miles in a northerly direction from Cedar Keys.

Pine Key, largely marsh, has a certain amount of solid ground rising from 2 to 3 feet above the general level. About one-quarter acre of this higher ground had been used as a sort of burial place, or cemetery. There had been considerable previous digging, and fragments of human bones and bits of earthenware of the most inferior quality lay scattered over the surface.

The cemetery was trenched in all directions.

In places, bones lay in profusion, while again burials were met with singly, the flexed burial, the bunch and the lone skull being represented. No cranial flattening was noticed. The remains, as a rule, were about 1 foot below the surface, though several burials were met with at a depth of 3 feet.

A "celt" was found not far from the surface, as were a shell drinking cup with a basal perforation, and many sherds, all of poor ware, undecorated in the main, though the check stamp and the complicated stamp were represented.

Also near the surface was the lower part of a ceremonial, mortuary vessel having a basal perforation made before baking. The portion found resembled an inverted cone. Just above the base were two deep, encircling grooves made when the clay was soft. The ware and workmanship were of the coarsest description.

Mound near the Shell-heap, Levy County.

This mound is in thick scrub, about 300 yards from the homestead of Mr. W. R. Young, who lives on the great shell-heap, to which we have referred, and is the owner of the mound in the rear. This mound, 6.5 feet high, 64 feet through its circular base, had been dug into from the NE. margin previous to our coming, a trench 6 feet wide having been carried to the center where it broadened to include a space about 10 feet in diameter. A few fragments of human bones and two or three bits of rude earthenware lay on the surface.

Seven large trenches made by us, not all of which were entirely carried to the base, some having been abandoned when results of others were noted, showed the mound to be mainly of oyster shells irregularly placed.

At the center a measurement from the top showed 18 inches of sand, 22 inches of shell, 14 inches of sand, 1 foot of shell, in order, going down. Beneath, was undisturbed sand. The mound probably was built on rising ground, as its height, taken from the margin, is not accounted for by these measurements.

On the south side of the mound trenching showed 18 inches of sand on top, with a solid mass of shells below, and other trenches gave but slightly varying results.

No human remains or artifacts were met with in our digging, though one bit of human bone, just below the surface, projected from the side of the former trench.

At Cedar Keys our mound investigation for the season was brought to an end.

A continuation of our work farther south hardly would have been consistent with the title of this report. Moreover, Mr. J. S. Raybon, captain of our steamer, who had worked so successfully for us to the northward and to the westward, had been unable to locate any new mounds of importance between Cedar Keys and

Tampa bay. It is only fair to say, however, that owing to the lack of inhabitants along that part of the coast, from whom inquiry could be made, certain mounds may have escaped him. Besides, several years before, we had covered the territory from Tampa almost to Clearwater Harbor (see outline map) with but negative results, while two men in our employ, one of whom was very familiar with the coast, had searched from Tampa to Anclote Key, finding only mounds previously located and dug into by Mr. S. T. Walker,[1] whose researches were continued still farther north without discovery of importance.

Mr. Cushing,[2] it is true, opened a mound at Tarpon Springs, in which he found fragments of interesting ware, but we believe this mound to have been an exception to the general run of mounds from Cedar Keys southward. Just north of Cedar Keys the great shell-heaps of the west coast begin, and neither on the east coast, where large shell-heaps are throughout, nor in the territory of the great shell-heaps on the west coast have we found the contents of mounds to be of much interest.

As we have stated, our work of last season ended at the eastern extremity of Choctawhatchee bay and began this year at the western end of St. Andrews bay, in direct continuation (see map).

During our season's work certain points were brought to our attention.

Going eastward along the coast, we saw the waning influence of Alabama and of the middle Mississippi district as to composition of ware, the admixture of shell[3] entirely disappearing, none having been met with by us east of Choctawhatchee bay, which marks also the easternmost limit of the polished, black ware of Mississippi, as found by us.

[1] Smithsonian Report, 1879.

[2] Proceedings American Philosophical Society, Vol. XXV, No. 153.

[3] In a thoughtful article in the "American Antiquarian," May and June, 1902, entitled "Primitive Keramic Art in Wisconsin", the author of that paper is inclined to believe that a mineral substance, and not pounded shell, is used to temper earthenware through parts of the mound region, where hitherto we have been led to believe pounded shell was used.

To determine this matter, we submitted to Prof. Harry F. Keller, Ph. D., a fragment of thick, porous earthenware found by us in Alabama, which contained a considerable amount of what we have always considered broken shell used for tempering.

Dr. Keller's report is as follows:

June 24, 1902.

"The analysis of the carefully picked material (shell) from the specimen of earthenware from Alabama gave the following results:

Insoluble in dilute acid, (Silica and ferruginous clay)	3.09%
CaO (Lime)	54.07
MgO (Magnesia)	.19
MnO (Manganous oxide)	.09
Fe_2O_3 (Ferric oxide)	.11
CO_2 (Carbonic anhydride)	41.58
P_2O_5 (Phosphoric anhydride)	.62
Moisture	.11
	99.86

"The small amounts of the oxides of iron and maganese may be derived from adhering matrix. The insoluble residue contains traces of carbonaceous matter."

Here we have almost pure carbonate of lime, showing the scaly fragments in the earthenware to be shell.

The growing influence of Georgia in decoration became noticeable also, the complicated stamp, the specialty of that State and of territory to the northward, coming more and more into use. Such being the case, we should look for the clay tempered with coarse gravel, the well-known "gritty ware" of Georgia, but it is not present.

The earthenware of the northwest Florida coast is purely aboriginal in style. Probably most of the mounds there ante-dated the coming of the whites, and where they did not, their builders saw too little of the strangers to suffer modification in their art. It is true that some writers have cited the presence of feet on aboriginal vessels as an indication of European influence, and such vessels are often met with in the mounds of the northwest coast, but we have seen vessels with feet, in various localities, in too many mounds in which no European artifacts were found, to coincide with this idea.

In material and decoration the pottery of the Florida northwest coast averages far above that of such mounds of peninsular Florida, in which earthenware is met with.

For one reason or another, the occurrence of earthenware vessels is infrequent in the burial mounds of the coast of peninsular Florida. We have searched almost the entire east coast between the Georgia boundary and Lake Worth without finding a single vessel, and our good friend, the late Andrew E. Douglass, devoted many seasons to mound work along the east coast, going even as far as Miami, with a like result.

On the west coast, Mr. Cushing found fragments of important vessels in the mound opened by him at Tarpon Springs, but from near that point southward, almost to the end of the peninsula, we saw not a single vessel of earthenware, though there are a few fragments in the shell-heaps.

It is true Mr. Cushing found several vessels of earthenware in the muck at Marco, with his great discovery of objects of wood, but the vessels were few in number and unimportant as to shape and decoration.

Presumably, then, the custom to inter earthenware vessels with the dead obtained but little, if at all, along the Florida east coast, and the lower half of the west coast of peninsular Florida. If, in these districts, vessels to any extent were put into the mounds, these vessels were of wood and perishable.

Superior as is the earthenware of the northwest Florida coast to most of that of the peninsula, it does not excel a few of the finest specimens met with by us in the mounds of the St. Johns river. A duck-vessel [1] from near the mouth of the St. Johns; sherds of excellent paste and superior decoration, from near Dunn's creek [2] (see outline map); still more beautiful ones from a neighboring mound; part of a vessel and a handle representing a vulture's head, beautifully incised and showing the fine yellow of the paste, alternating with crimson pigment, from a mound near Lake Monroe, hold their own with the finest earthenware of the northwest coast of Florida.

[1] "Certain Sand Mounds of Duval County, Florida." Plate LXXXIII.

[2] "Certain Sand Mounds of the St. Johns River." Part I, Pl. II, Fig. 1. Incidentally, at this mound was the southernmost occurrence of ware bearing the complicated stamp decoration.

We have two hypotheses to offer to account for this:

1.—That the aborigines of the peninsula possessed fine ware, but did not, as a rule, inter it with the dead.

It must be borne in mind that the natives of the peninsula did not make great mortuary deposits of earthenware as did those of the Florida mainland, the vessel of earthenware being simply one of a great number of objects from which selection was made. Fewer vessels were put into the mounds, and as earthenware was not so exclusively a mortuary selection, perhaps less attention was paid to the quality of that taken for burial. Besides, the interment of "freak," or ceremonial, ware, which is always inferior to the other ware of the district where it was used, was more largely practised in the peninsula than it was on the northwest coast and, therefore, the pottery of the peninsular mounds may not be representative.

2.—That the finest vessels of the peninsula were importations.

From the island of Marco, southwest Florida, we got two large bird head handles, of excellent design, found alone, one representing the head of a turkey, the other that of a predatory bird. Around one of these heads a groove had been made to permit use as a pendant. The other head had doubtless served a similar purpose, as circular spaces, through which a cord could pass, had been left, at the time of manufacture, through the neck and through the bill. Not only was the workmanship of the heads markedly that of the middle Mississippi district or of the Gulf, but the ware was what is known as shell-tempered, which ware was in use in the districts we have named, but not in peninsular Florida. These heads were doubtless importations, and other fine specimens of ware may have been importations also.

On the whole we are inclined to believe that the best ware found in the peninsula was exceptional and perhaps got there through barter. The lower average of excellence of sherds in the peninsula argues a supply of inferior vessels, and the fact that the "freak," or ceremonial, ware is so much below the standard of that of the northwest coast might indicate a lower quality for vessels of other classes also. Had the natives of the peninsula possessed vessels of the highest grade in great numbers, we believe, in one way or another, more indication of it would have come to light.

In the first part of this report we spoke of a mortuary custom prevailing in peninsular Florida[1] to knock a hole through the base of a vessel, presumably to "kill" the pot, that its soul might accompany that of the dead man. We spoke of a refinement of this custom, and described vessels of fantastic form and flimsy material made expressly for interment with the dead, in the bases of which holes

[1] In the "American Antiquarian," Sept.–Oct., 1902, is a paper by Mr. Francis U. Duff, on the antiquities of the Mimbres valley, New Mexico, describing, among other things, the finding of "large bowls inverted over the crania of the departed. Each of these bowls, before being deposited in the grave, had a small hole broken in its bottom." It is interesting to note the occurrence of the mortuary perforation of the base of vessels in this remote region so far removed from where this mortuary custom flourished at its fullest. In the Mimbres valley, however, bowls were not inverted over lone skulls or skulls with a few scattered bones, as they were in the graves of the Florida northwest coast, but were placed over skulls interred with their skeletons.

had been made previous to the baking of the clay. Incidentally, we found this "freak," or ceremonial, ware in the peninsula, from the mouth of the St. Johns river to Lake Beresford (see outline map), going southward, and in the lake district at the head of the Ocklawaha river.

A few examples of this ready-made "freak" ware were met with by us east of Pensacola bay during our work last season. During this year's investigation, as our readers may recall, examples of this form were found in increasing numbers, and individual vessels were often of much greater size than anything of the kind we had met with to the westward on the coast, or, incidentally, in peninsular Florida, save in the mounds of Volusia, south of Lake George.

As our work progressed more to the east, a new feature in "freak" ware was encountered. In the mounds of St. Andrew's bay two vessels of a new type, and fragments of similar ones, were found, while farther to the east vessels of this kind were encountered in considerable numbers. These vessels were life-forms, usually, but differed from other life-forms of the same district, in that they were inferior to them as to ware and workmanship, and that they had various perforations made previous to baking, in the body of the vessel as well as the customary one in the base.[1]

An interesting custom noted with but few exceptions along the northwest coast was the placing in the mounds of general deposits of earthenware, nearly always in the eastern part of the mound. These deposits were found in darkened sand, often at the very edge of the mound, and continued with the blackened sand, a few vessels together, in toward the center or to it. Sometimes the deposits were met with at some little distance in from the margin, but nearly always in the eastern side of the mound.

These masses of blackened sand in which the general deposits of earthenware lay were noticed by us in the mounds during our former season's work and were referred to by us in Part I of our report. So almost universal was the juxtaposition of darkened sand and general deposits of ware in the mounds, during our work this season, that considerable thought was devoted by us to the matter. Sand of this

[1] Among numbers of small "freak" vessels found by us in the Grant mound, near the mouth of the St. Johns river, was part of a vessel filled with perforations, like a sieve. We are uncertain whether or not this vessel should be included in the same class as those having occasional perforations in the body.

The incense-cups of Mexico and of Central America, though they have perforations of the body, made before baking, do not seem to us to be of the same class as these large vessels from northwest Florida, which have basal perforations in addition to those in the body. These latter vessels with their ready-made body-perforations would seem to be intimately connected with the ceremonial vessels of peninsular Florida, since both classes possess the perforation of the base, made before the baking of the clay, though the vessels of peninsular Florida do not show the body-perforations which are probably only an amplification of the mortuary perforation of the base. Therefore, as the ceremonial vessels of peninsular Florida, being without body-perforations, could not have served as incense-burners, it is not likely that the ceremonial vessels of northwest Florida, which are so nearly related to the others, though possessed of body-perforations, were intended for the burning of incense.

The Twentieth Annual Report of the Bureau of American Ethnology will consist of Prof. W. H. Holmes', "The Pottery of the Eastern United States," a most admirable memoir, part of which it has been our good fortune to see in manuscript.

We earnestly advise those interested in the subject of aboriginal ware carefully to study this memoir, on its appearance.

kind was often carefully examined by us for charcoal, but none was found, nor was adjacent sand burnt or discolored as by fire. In our account of the mound at West Bay post-office, in the early part of this volume, we have stated that a sample of this blackened sand, examined chemically and microscopically, showed its color to be due to carbonaceous matter, very probably of animal origin, and that the material, in all probability, could not have come from anything in the vegetable line. As this report is not intended for popular reading, in all probability our readers are as able to draw conclusions as we are. It would seem to us, however, that masses of animal matter, incinerated in a way to escape mixture with charcoal, have been mingled with sand which was placed in that part of the mound devoted to deposits of earthenware, put in for the dead in common. What these masses of flesh consisted of we are unable to decide. If the flesh belonged to lower animals and the bones were not removed before burning, and it seems unlikely that they should have been, the incineration must have been complete, as particles of half-burnt bone are not present in the sand.

If we suppose, on the other hand, that the flesh which we know was sometimes stripped from human skeletons when taken from the dead-house, was cremated, the absence of particles of bone can be accounted for. We think this latter supposition the more probable since aboriginal cremation did not seem to reduce bones in a thorough way, judging from our rather extensive experience of the matter in the mounds of Georgia.

Burials of human remains, also, were in greater numbers in the eastern portions of the mounds, sometimes being there and in the central parts, exclusively. In other cases, however, human remains were met with throughout the entire mound.

No new feature as to form of burial was noted during this season's work. The lone skull, the bunch, the flexed burial, the burial at length were met with; also loose bones scattered here and there. The urn-burial, also, was found in two localities.

The question of urn-burial in Florida is an interesting one since we know the custom to have been largely in vogue in Alabama and in Georgia, and yet there is no evidence [1] of the extension of the custom into peninsular Florida.

We have seen how large bowls were put over skulls at Perdido bay, the boundary between Alabama and Florida, and how the custom, continuing eastward into Florida, was noted along Santa Rosa sound and at the eastern extremity of Choctawhatchee bay, where, also, in one instance, an inverted bowl was found covering another bowl containing human remains.

This season we have remarked the existence of a cemetery with urn-burials still farther east, at the town of St. Andrews, and have found a single urn-burial in a mound on Ocklockonee bay farther yet to the eastward, though still on the mainland.

Beyond this point, in all Florida, we have met with no example of urn-burial, nor is there one on record.

[1] With the exception of a statement made in a newspaper by an investigator of a single mound and omitted from his official report.

Cremation, which we met with so frequently in Georgia, but saw but once during our work on the Alabama and Tombigbee rivers, was not noted by us during our first year's work along the northwest Florida coast, and but twice, unmistakably, during this, our second year's work. In the peninsula of Florida we have not met with true cremation where it was evidently the purpose to burn the body as a form of burial, such cremation as is found there apparently being where single bones or parts of skeletons have lain in close proximity to ceremonial fires. These fragments of burnt bone are often found lying with bones unaffected by fire, while, at times, a skeleton is seen to have the bones of one arm burnt or calcined, or sometimes a portion of the skull, and the like.

Cremation, then, as a form of burial, cannot be said to have obtained in peninsular Florida and was practised but occasionally in the mainland, or northwestern portion.

There seems to be a possible explanation for this occasional occurrence of cremation in a district where inhumation was so generally practised. Cabeça de Vaca, who, as the reader is aware, spent some years among the aborigines of the northwest Florida coast, tells us that persons there in general were buried, but that doctors were cremated. In our work on the mounds of the Georgia coast we pointed out that this statement could not apply to that part of the country, since cremation was very widely practised there, and, moreover, often included the bodies of infants. But along the northwest Florida coast, the district of which Cabeça de Vaca's statement was made, the result of our investigations seems to bear out the assertion.

It was our intention, another season, to carry our investigation from Mobile bay westward along the coast, in the endeavor to trace connection between that district and the region we have covered to the east.

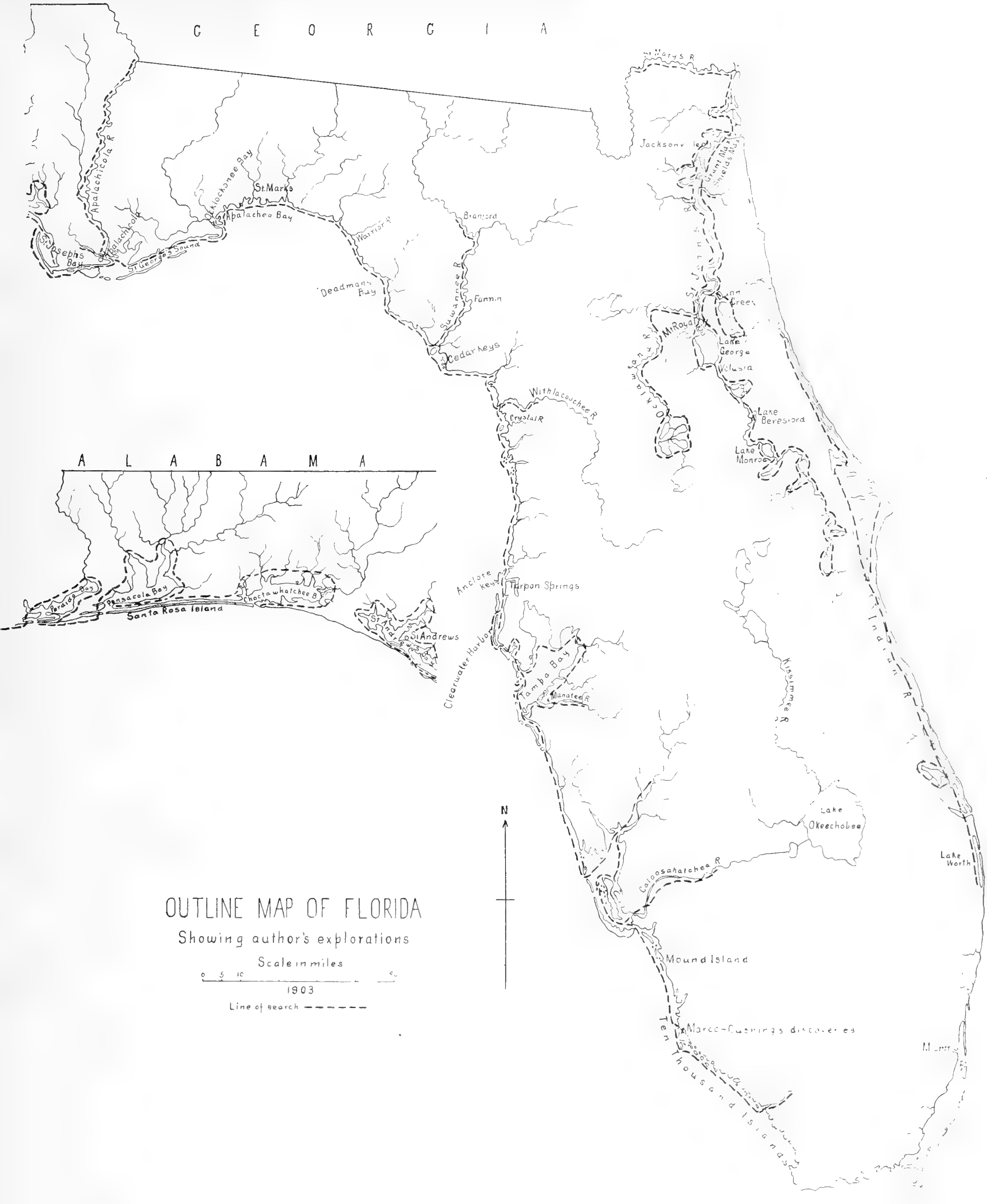
Since our return, this spring and summer (1902), Mr. J. S. Raybon, captain of our steamer, who has in previous years so successfully located mounds for us, went over part of Mobile bay and most of the Mississippi coast.

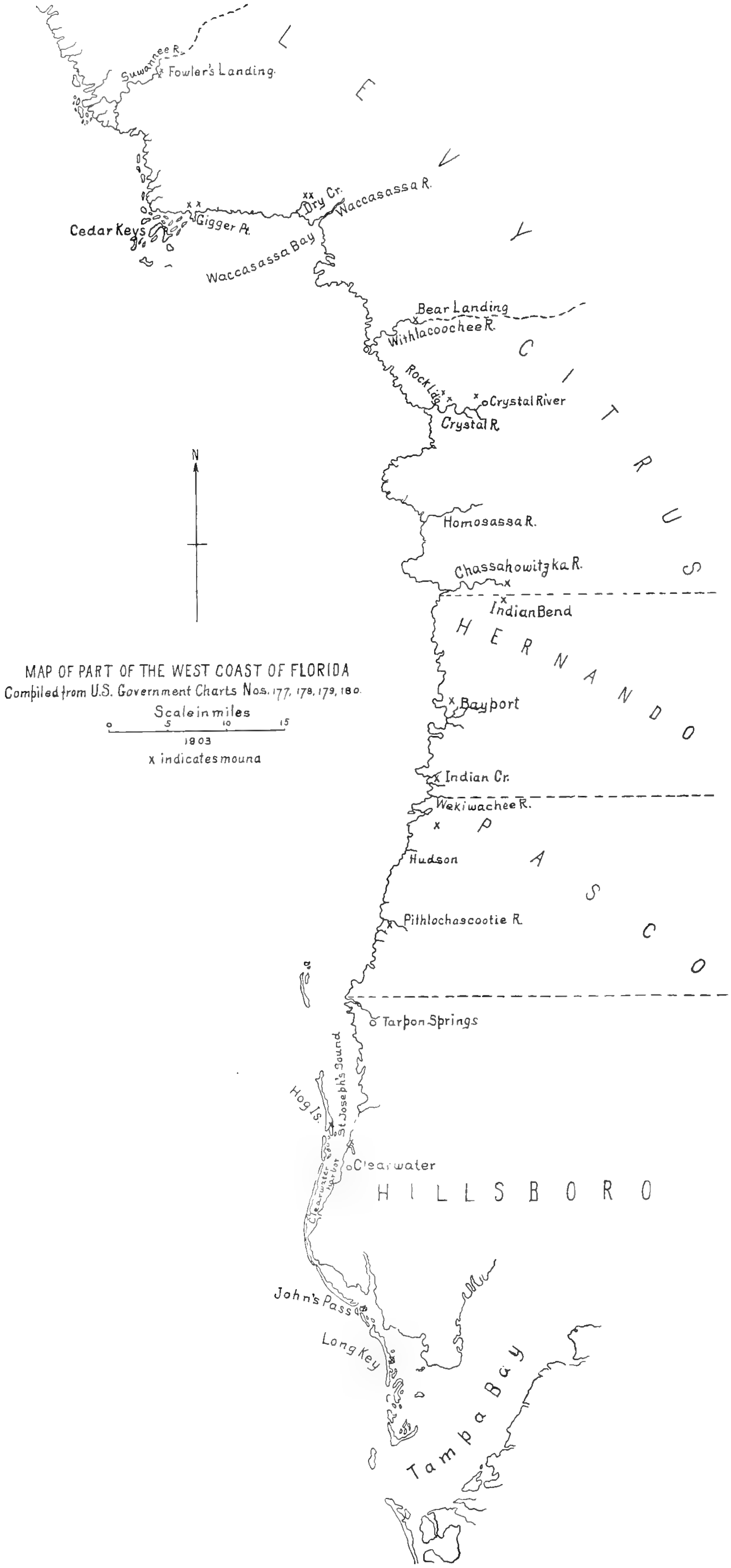
A few mounds rewarded his search on the eastern shore of Mobile bay, but along the coast of Mississippi, apart from shell-heaps, almost nothing was met with.

INDEX.

CERTAIN ABORIGINAL REMAINS OF THE NW. FLORIDA COAST.

PART II.


OUTLINE MAP OF FLORIDA
Showing author's explorations
Scale in miles
1903
Line of search
GEORGIA
ALABAMA
Apalachicola R
St Josephs Bay
Apalachicola
St Georges Sound
Ocklockonee Bay
St. Marks
Apalachee Bay
Warrior R
Deadmans Bay
Branford
Suwannee R
Fannin
Cedar Keys
Withlacoochee R
Crystal R
Anclote Keys
Tarpon Springs
Clearwater Harbor
Tampa Bay
Manatee R
Perdido Bay
Pensacola Bay
Santa Rosa Island
Choctawhatchee B
St Andrews
St Marys R
Ocklawaha R
Mt Royal
Lake George
Volusia
Lake Beresford
Lake Monroe
Kissimmee R
Indian R
Lake Okeechobee
Caloosahatchee R
Lake Worth
Mound Island
Ten Thousand Islands
N



MAP OF PART OF THE WEST COAST OF FLORIDA
Compiled from U.S. Government Charts Nos. 177, 178, 179, 180.
Scale in miles
0 5 10 15
1903
x indicates mound
LEVY
CITRUS
HERNANDO
PASCO
HILLSBORO
N
Suwannee R.
Fowler's Landing
Cedar Keys
Gigger Pt.
Dry Cr.
Waccasassa R.
Waccasassa Bay
Bear Landing
Withlacoochee R.
Rock Ldg.
Crystal River
Crystal R.
Homosassa R.
Chassahowitzka R.
Indian Bend
Bayport
Indian Cr.
Wekiwachee R.
Hudson
Pithlochascootie R.
Tarpon Springs
St. Joseph's Sound
Hog Is.
Clearwater
Clearwater Harbor
John's Pass
Long Key
Tampa Bay

CERTAIN ABORIGINAL MOUNDS OF THE CENTRAL FLORIDA WEST-COAST.

By Clarence B. Moore.

During the seasons 1901 and 1902 we investigated the aboriginal remains of the northwest Florida coast, beginning at Perdido bay, the coast-boundary between Alabama and Florida, and ending at the town of Cedar Keys[1] (see outline map).

This season (1903), our work was directly continued down the west coast of Florida, beginning at the Suwannee river, just above Cedar Keys, and continuing through Waccasassa bay, Withlacoochee bay, Crystal bay, Homosassa bay, Chassahowitzka bay, St. Joseph's sound and along the Gulf coast and islands to Tampa bay, including short journeys up the various rivers along the route.

Much of the territory covered by us is sparsely settled, so that information as to the locality of mounds is difficult to obtain and, therefore, although search had been made in advance for us by two agents, and over part of the distance by four, yet we doubt not that some mounds have escaped us, as, no doubt, have numerous cemeteries. By cemeteries, we mean where burials have been under level ground, unmarked by mounds. We do not believe these burials were enclosed in urns.

As we had anticipated, the yield of earthenware from the mounds of the central west-coast of Florida did not equal that from the mounds of the northwest Florida coast, though a few vessels found intact and many sherds, showed that the aborigines of the central west-coast had been possessed of some excellent ware bearing decorations showing no mean ability. Life-forms in earthenware were conspicuous by their absence.

In reference to the earthenware described in this report we quote from our report of last season.

"All measurements of earthenware reported in this volume are approximate.

"It must be borne in mind in respect to process work that reductions in size are made with regard to diameter and not area. If a diagram four inches by two inches is to be reduced one-half, each diameter is divided by two and the reproduction, which is called half size, is two inches by one inch. The area of the original diagram, however, is eight square inches, while that of the so-called half-size reproduction is two square inches, or one-quarter the area. To find the actual size of a design shown in diagram, multiply the length and the breadth by two, if the diagram is given 'half size;' by three, if 'one-third,' and so on.

[1] "Certain Aboriginal Remains of the Northwest Florida Coast," Parts I and II. Journ. Acad. Nat. Sci. of Phila. Vols. XI, XII.

"In a few cases partial restoration of vessels has been attempted, but always in a material differing in color from the original, so that the restoration may be readily recognized, and it has been done only when the remainder of the vessel clearly indicated the size and shape of the missing part."

All objects found by us, with the exception of certain duplicates sent to the Museum of Phillips Academy, Andover, Mass., may be seen at the Academy of Natural Sciences of Philadelphia.

Dr. M. G. Miller, who has aided us in all our previous mound work, determined as to human remains this season as before, and assisted us in a general way in the field work and in putting this report through the press.

Our warm thanks are tendered owners of the mounds investigated by us, who, to a man, when requested, accorded fullest permission to dig.

Mounds Investigated.

Mounds near Fowler's Landing, Suwannee river (2).
Mound near Cedar Keys, Gulf coast.
Mound near Gigger Point, Gulf coast.
Mounds near Dry creek, Waccasassa bay (2).
Mound near Bear Landing, Withlacoochee river.
Mound near Rock Landing, Crystal river.
Mound near the Shell-heap, Crystal river.
Mound near Crystal river settlement, Crystal river.
Mound near Chassahowitzka river.
Mound near Indian Bend, Gulf coast.
Mound near Bayport, Gulf coast.
Mound near Indian creek, Gulf coast.
Mound near Wekiwachee river, Gulf coast.
Mound near Pithlochascootie river.
Mound on Hog island, St. Joseph's sound.
Mound near Clearwater, Clearwater Harbor.
Mound near John's Pass, Gulf coast.
Mound on Long Key, Gulf coast.

MOUND NEAR FOWLER'S LANDING, LEVY COUNTY.

Fowler's Landing is about sixteen miles above the mouth of the Suwannee river, on the right-hand side, going up, though but a short distance, by land, from the waters of the Gulf, so the mound may be fairly classed as belonging to the coast. It was in thick scrub, on property of the East Coast Lumber Co., about one-quarter mile in NE. direction from the landing. Adjacent, were excavations whence material for the mound had been taken. This mound, of sand, as were all investigated by us along the coast, unless otherwise described, was circular in outline; was 7 feet high and 50 feet across the base. It had suffered considerably

from previous digging. In addition to a number of smaller holes, a trench about 4 feet deep and 11 feet wide had been dug from the western margin about 20 feet in toward the center. Over the surface of the mound were fragments of human bone and bits of earthenware. This mound, which was completely dug down by us, had a clearly defined base-line, marking the original surface upon which the mound had been piled. No grave-pits were present, and of the forty-seven burials found by us, none lay upon the base and none was over 3.5 feet from the surface.

Burials were encountered near the margin and were not confined to any part or parts of the mound. They increased in number as the digging progressed, the majority of the burials being in the body of the mound. In form, the burials were of the bunched variety and consisted of certain bones without the cranium; bones with one, two or three skulls; and, in one case, a bunch with four skulls. The bones were all badly decayed. No crania were in a condition to keep, though a few calvaria, which held together temporarily, showed no cranial flattening.

Objects deposited with the dead were singularly few. Near a burial, lay fragments of a marine shell (*Fulgur*).[1] With another burial was part of an earthenware vessel having a bird-head handle but, as sherds were scattered throughout the mound, the proximity of this one may have been accidental. Hammer stones, pebbles and the like were conspicuously absent. Two "celts," not associated with burials, fell with caving sand.[2]

In the extreme edge of the mound, on the west, was an undecorated pot of very inferior ware, badly broken. With it was a vessel with globular body and upright neck around which was a complicated stamp decoration. Both these vessels had the usual mortuary mutilation made by knocking out a part of the bottom, as had all vessels met with by us in this mound.

It is interesting to note the occurrence here of the complicated stamp, the specialty of Georgia. It is frequently met with to the northward in Florida, as the readers of our two reports on the northwest coast may recall, and its occurrence much farther south along the coast will be described in this report. On the St. John's river, however, it was found by us no farther south than about ten miles above Palatka, about on a line with this Fowler's Landing mound.

Also in a marginal part of the mound, to the southeast, were many large fragments of vessels, undecorated, all of inferior ware, water-soaked and crushed. In addition, four vessels were recovered, nearly whole, with the exception of the basal perforation. Of these, Vessel No. 4, undecorated save for several encircling incised lines, somewhat resembles a dumb-bell in shape, though the base has been perfectly flat. A vessel much like this one is shown in Fig. 151 in the second part of our report on the northwest Florida coast.

[1] All determinations of shells have been made by Dr. H. A. Pilsbry and Mr. E. G. Vanatta, of the Academy of Natural Sciences of Philadelphia.

[2] Thanks are due for determination of rock material, from which objects mentioned in this report are made, to Dr. E. Goldsmith and Mr. S. H. Hamilton, of the Academy of Natural Sciences of Philadelphia. As it has not been deemed advisable to mutilate specimens, identifications are approximate only. It has not been thought necessary to give the rocks from which the "celts" found by us were manufactured. None seemed to present new features, and many were given to owners of mounds.

Fig. 1.—Vessel No. 5. Mound near Fowler's Landing. (Full size.)

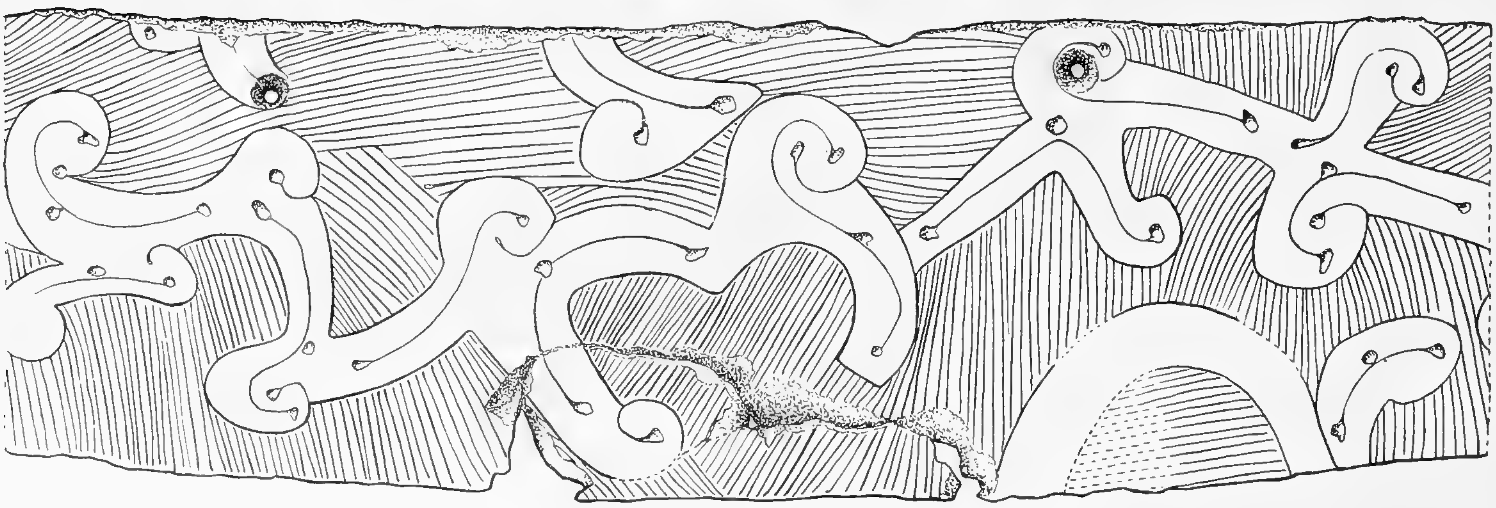


Fig. 2.—Vessel No. 5. Decoration. Mound near Fowler's Landing. (Half size.)

Vessel No. 5, shown in Fig. 1, has an interesting incised decoration shown diagrammatically in Fig. 2, where restored portions are given in broken lines. There are two holes for suspension.

With these vessels was one entirely undecorated and another with a complicated stamp decoration around the neck.

Vessel No. 6, found alone in the western margin of the mound, is of most excellent yellow ware and of interesting shape and decoration. The vessel, shown in Fig. 3, is intact, save for a small basal perforation. The decoration is given in diagram in Fig. 4.

Fig. 3.—Vessel No. 6. Mound near Fowler's Landing. (Full size.)

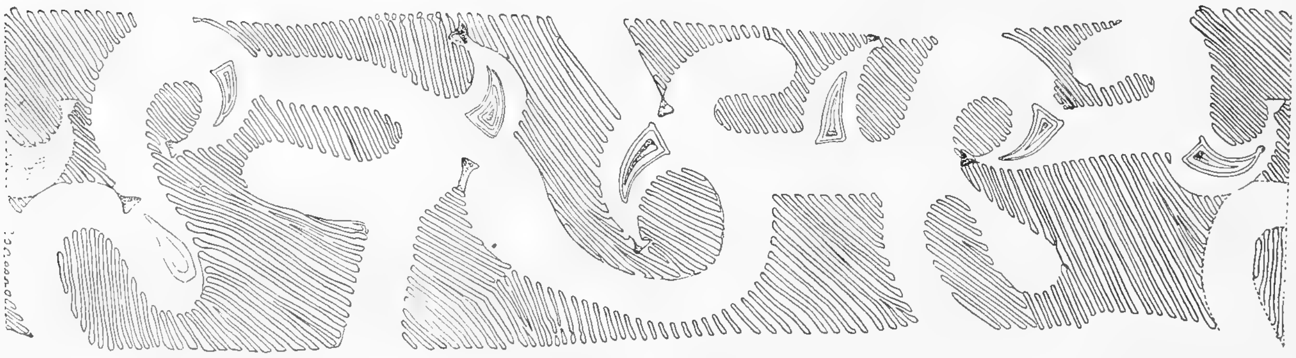


Fig. 4.—Vessel No. 6. Decoration. Mound near Fowler's Landing. (One-third size.)

Fig. 5.—Vessel No. 7. Mound near Fowler's Landing. (Two-thirds size.)

In the margin of the eastern part of the mound were several undecorated sherds and Vessel No. 7 (Fig. 5), having two holes for suspension, on the same side and so near the base that it is plain the vessel was either ceremonial or, at all events, not intended for liquids. A part of the rim has been restored.

From near the base came an undecorated vessel in the form of a much-truncated cone.

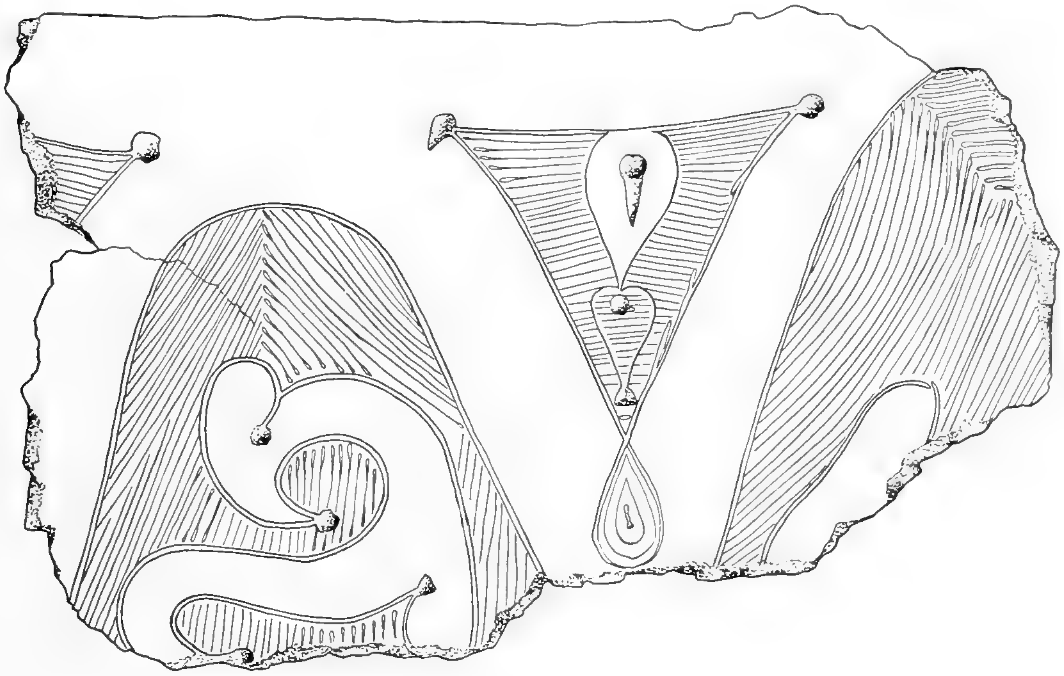


FIG. 6.—Sherd. Mound near Fowler's Landing. (Half size.)

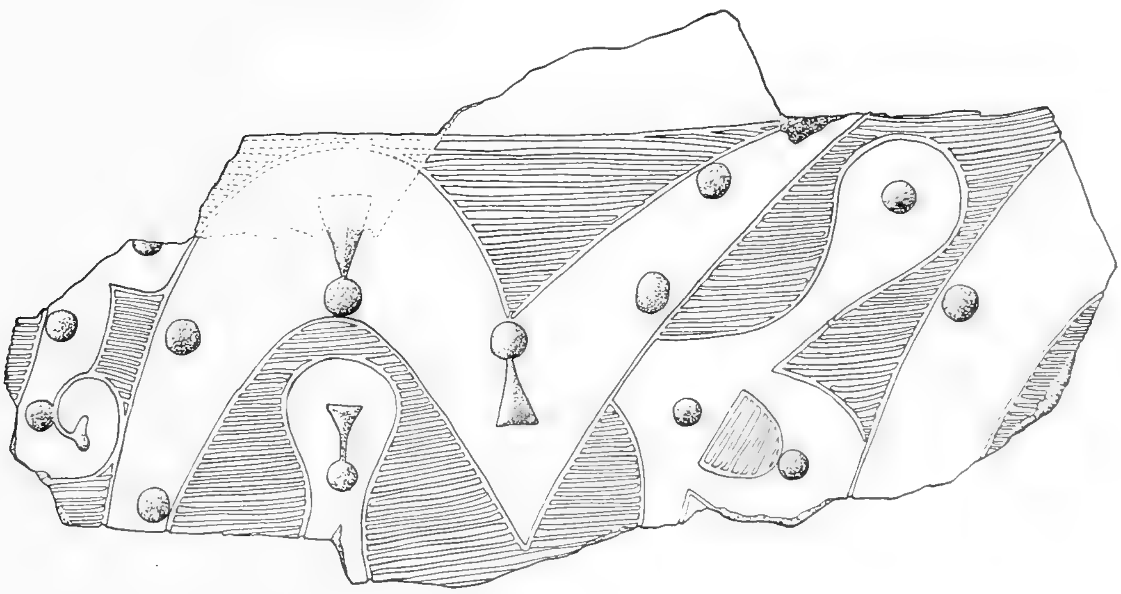


FIG. 7.—Sherd. Mound near Fowler's Landing. (Half size.)

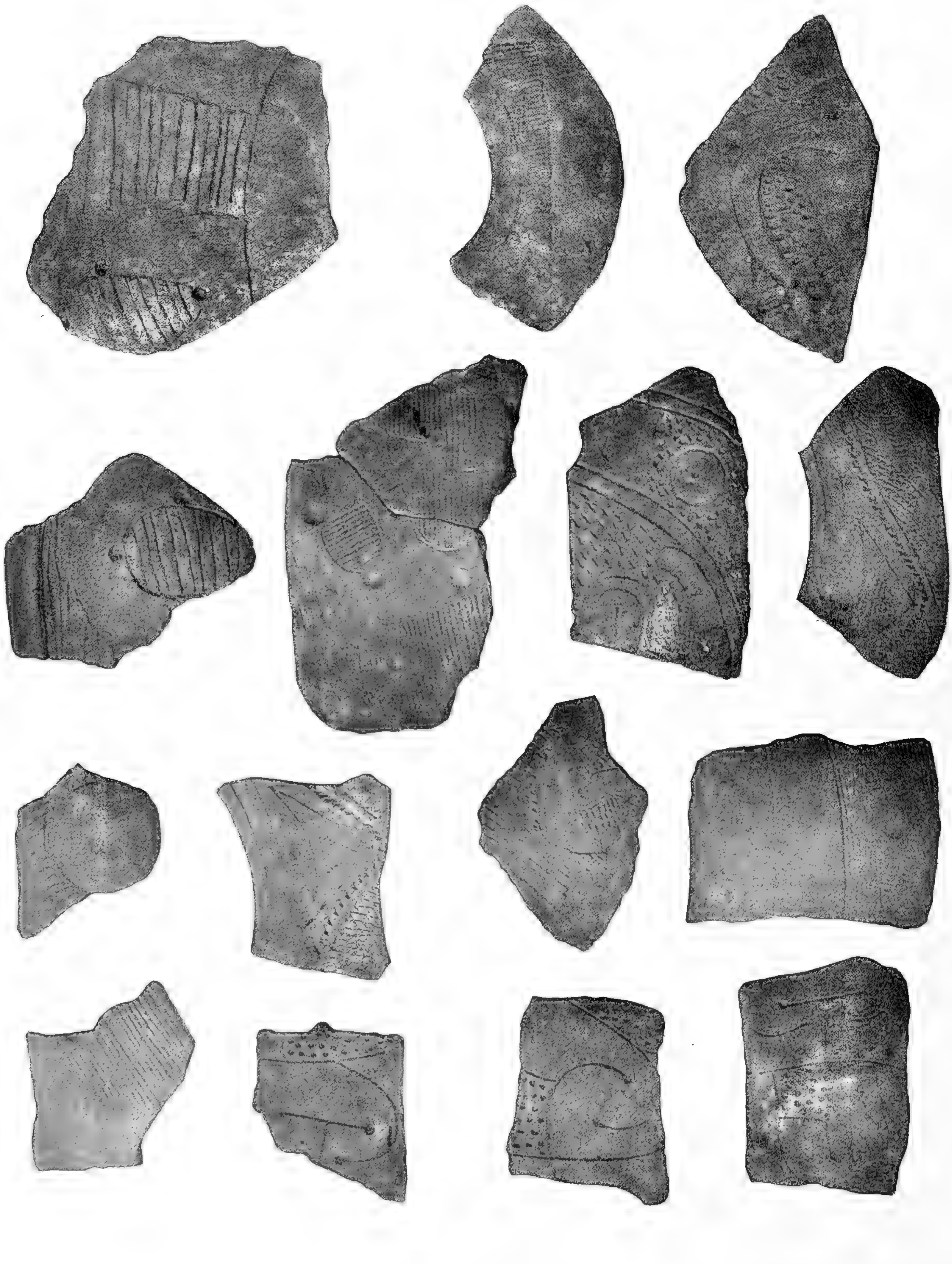


Fig. 8.—Selection of sherds. Mound near Fowler's Landing. (Half size.)

Smaller Mound near Fowler's Landing, Levy County.

About 75 yards in a SW. direction from the other, was a low mound of irregular shape, literally dug to pieces, presumably by the ubiquitous treasure seeker, as one great central excavation extended considerably below the base. So great was the wreck that no conclusion as to the original height, diameter or shape could be arrived at. Though the surface was covered with sand from the former excavations, no fragment of bone or of earthenware was apparent and considerable digging, here and there, by us yielded but a single fragment of earthenware. Presumably, this mound was of the domiciliary class.

Near the surface were scattered parts of a human effigy-vessel. Most diligent search failed to recover the facial parts which, possibly, had not been placed in the mound.

Throughout the mound were various sherds, as a rule of inferior ware, though occasionally of excellent quality, in no case showing sand-, grit-, or shell-tempering. No small check-stamp was present, and but few sherds showed the complicated stamp.

In Figs. 6, 7, are shown, diagrammatically, two sherds from this mound, while in Fig. 8 a selection of sherds from the mound is given. It is evident that the makers of this mound favored the incised and punctate decoration.

In the mound were no masses of sand artificially colored and surrounding deposits of earthenware, such as we found in the mounds of the coast, to the northward.

The record of the discovery of a fish-spear of native copper will be given here, incidentally, as the place where the spear was found is too far up the Suwannee river rightly to be included in a description of the coast-territory.

Fig. 9.—Fish-spear of native copper, from near Fannin, Suwannee river. (Full size.)

During our visit to Cedar Keys we met Decatur Pittman, Esq., of that place, Justice of the Peace, and a collector of aboriginal relics. By him we were shown a copper fish-spear 11.5 inches in length (Fig. 9), of which Mr. Pittman gives the following history :—

About seven years ago as Mr. John Clark, his father and his brother were digging in the garden of their place which is two miles below Fannin (see outline map), on the Suwannee river, they found the spear about eighteen inches below the surface.

Somewhat over two years ago Mr. Pittman heard of the finding of the spear and, at a later period, acquired it.

The value of this implement of native copper, coming from Florida, was fully appreciated by Mr. Pittman, who relinquished the spear to the Academy of Natural Sciences of Philadelphia, only because he realized, with true scientific spirit, that such a specimen was more fittingly placed in a museum in perpetuity than in a private collection.

This spear, a unique discovery as coming from Florida, would not be of unusual rarity in Wisconsin, according to Mr. H. P. Hamilton, of Two Rivers, Wisconsin, the well-known expert and collector of "coppers."

There is one point about the spear which deserves close attention. By examining the cross-sections the reader will see that a small semi-enclosed space has been left on one side of the spear, which might appear as though intended for a shaft, and yet that this space is too restricted to hold a wooden shaft of a size necessary for the work required of the spear. Neither Mr. Hamilton nor Mr. David Boyle, of the Provincial Museum, Toronto, who is very familiar with "coppers," believes that this space was intended for the insertion of a shaft. Mr. Boyle writes :

"As to the drawing you send of the fish-spear found in the Suwannee River and the question you propound respecting the small space apparently left for the insertion of a handle, I beg to give it as my opinion that it was never the intention of the maker so to use the narrow channel. The spear or harpoon has been made from a thin piece of copper and the maker had sufficient gumption, no doubt as the result of experience, to know that a piece of native copper of the size your diagram shows this to be, would bend when an attempt was made to employ it in giving an effective stroke. He has, therefore, hammered down both edges for the purpose not only of strengthening his tool, but of giving it a tolerably uniform breadth, and this shank was no doubt inserted *in* a handle rather than having been prepared for the insertion *of* a handle. Perhaps it was with only the latter object in view (*i e.* giving it a uniform breadth) that the hammering was done at all because he could reduce his material to a regular form by beating down the edges much more rapidly than by cutting away the superfluous material. I think, however, there can be little doubt that the ancient coppersmith had arrived at the knowledge that hammering the metal gave it stiffness apart from any other reason why, as in this case, such work was performed. If this tool had been inserted in a handle I sup-

pose the handle was split, the tool being placed in the cleft, and then securely bound with either animal or vegetable fibre."

Although other mounds on the Suwannee river may not be considered coast mounds, yet, as no mound should be investigated without a public record of the fact, it has been thought best to give here, incidentally, certain work done by us on the river.

A mound near Jenning's Landing, Lafayette Co., about thirty miles by water from the mouth of the river, just bordering the swamp, about a quarter of a mile in a westerly direction from the landing, was 4.5 feet high and 62 feet across the base. Careful trenching yielded: four small bunched burials and a few scattered bones, near the surface; a few uninteresting sherds; a mass of chert; a rude arrow-head or knife, of the same material.

Fannin is at the NW. corner of Levy County (see outline map). About one-third of a mile in a northerly direction from the landing is a mound on property of Messrs. R. L. Tison & Co., of Fannin. The mound, 2 feet 8 inches high, from 46 feet to 56 feet across the base, variously measured, was carefully dug and trenched by us. One or two sherds only, were met with.

About one-half mile in an ENE. direction from Fannin is a mound showing much previous digging. Its height is 4.5 feet; its basal diameters are 46 to 64 feet. Thorough trenching yielded absolutely nothing.

At Fayetteville, Lafayette Co., about 12 miles above Fannin, is a mound on property of Mr. John E. Moriarty. The mound showed traces of previous digging in almost every part. Its height is 4 feet 8 inches; its basal diameter, 64 feet. Practically, every untouched portion of the mound was demolished by us. Remains of a disturbed skeleton were found at the beginning of the body of the mound and, farther in, were four small bunched burials, three with a single skull each, and one with two crania. Another burial consisted of a single skull with another skull immediately below it. These burials ranged from 3 feet to 4 feet 3 inches in depth. With one was a "celt" of hard rock, about 5 inches in length, and a single chip of chert. Near the base, in two places, were deposits of mussel-shells (*Unio infucatus*), unassociated with bones. There were in the mound also several flakes of chert, and two sherds, one with incised, dentate marking in a punctate field, another with rude line and punctate decoration.

Within sight of Rocky Landing, Lafayette Co., is a mound of sand, as are all we investigated on the Suwannee river, which had seen much previous digging. Its height is 4 feet; its basal diameter, 40 feet. All untouched portions, practically, were dug through by us. Near the center of the mound, 3.5 feet down, was a skull in fragments and about 1 foot distant, small fragments of bones with sand tinged with hematite, and a neatly made lance head of chert, 4 inches long. Near bits of skull and decayed fragments of other bones, with charcoal nearby, was a "celt." Another "celt" was found in sand thrown out by one of our diggers. In the SW. part of the mound, about 6 feet from the extreme margin, 3 feet 4 inches down, was a coarse bowl of somewhat over 1 pint capacity, of ordinary form and with the usual basal mutilation. The decoration consists of incised encircling lines below the rim with two additional encircling lines beneath, made up of punctate markings. With this vessel was a mass of fragments mostly of undecorated ware, among which was all or nearly all of a large bowl. There were also parts of a vessel with a decoration of rudely made incised encircling parallel lines.

The investigation was continued to Branford with negative results.

The Suwannee river, famous in song, has flat swampy banks, save in places, as far up as Branford. Beyond this point, we are informed, the river is narrow with less marshy surroundings. We have crosssed the river at Ellaville, much farther up, where the stream is picturesque and the banks rise considerably above the level of the water. This portion of the stream no doubt invited aboriginal occupation.

Mound near Cedar Keys, Levy County.

This mound, in hammock[1] land, at the edge of the salt marsh bordering the Gulf, is about 3 miles in a NNE. direction from Cedar Keys, on property of Hon. E. J. Lutterloh, mayor of that place. Great excavations near by, whence sand for the mound was taken, give to it an appearance of considerable altitude but, measured from the general level, the height is 8 feet. In shape the mound is irregular, with basal diameters of 85 feet and 133 feet.

[1] As to the meaning of the word "hammock" see pg. 140 of our second part of "Certain Aboriginal Remains of the Northwest Florida Coast."

This mound, which had every appearance of belonging to the domiciliary class, was carefully trenched by us without the discovery of even a remnant of bone or a fragment of pottery.

Mound near Gigger Point, Levy County.

Gigger Point, which extends into the Gulf, is about three miles in a NE. direction from Cedar Keys. At the rear of this point is the property of Mr. A. M. Dorsett, resident on the place. The mound, circular in outline, was in a cultivated field, and itself had been ploughed over for a considerable period. There had been much previous digging in various parts of the mound, but in a superficial way only. The diameter of base was 46 feet. The height, at the time of the total demolition of the mound by us, was 5 feet, but the original height had been lessened at least 2 feet by recent digging, as was shown by partly uncovered roots of a palmetto on the upper part of the mound. Fragments of human bones and bits of undecorated earthenware were scattered over the surface in every direction.

Burials were met with in every part of the mound, from the margin to the center, the great majority being skeletons which had been buried denuded of flesh, but held together by ligaments. This was shown in various cases where bones were inverted or otherwise out of their proper position. Two burials lay in shallow graves beneath the base. Three were associated with oyster-shells, not heavy masses of shell, but thin deposits above and on the sides. Sand, crimson from hematite, was with one burial.

Forty-six of the skeletons were flexed on the right; 34 on the left. There were also 3 skeletons full length on the back; 3 squatting; one partly flexed on the left side; and the bones of an infant. In addition, there were in the mound: many bones scattered by previous diggers; several aboriginal disturbances made by cutting through skeletons to make way for others; several skulls, each with a few small bones in association; one single skull near the base, which may have been an aboriginal disturbance. There were also several masses of bones which fell in caving sand, and three or four burials which resembled the bunched variety, but may have been aboriginal disturbances.

The bones in this mound were in excellent condition, comparatively, which may be accounted for by a deposit of shell extending through about one-half the mound, as though a smaller mound had been covered with shell and then enlarged as to height and area. It has ever been our experience that presence of shell in a mound acts as a preservative to bones, doubtless through infiltration of lime-salts.

Ten skulls were saved in good condition (Acad. Nat. Sci. Catalogue Nos. 2196 to 2205, inclusive). Neither these skulls nor any in the mound, noted by us, gave evidence of cranial compression.

Considering the number of burials present in the mound, artifacts met with were few and unimportant. Unassociated, but perhaps separated from burials by previous digging, were: one lance-head of chert; mica, in two places; a clam-shell with a neatly made circular hole near the center, probably for the insertion of a handle; a

chert hammer-stone carefully worked; a shell gouge; part of a lance-head of chert, 5.6 inches long, 2.5 inches in maximum breadth, the point of which, broken by the blow of a spade, was not recovered; two masses of lime-rock, each with a circular hole, probably used as sinkers; a cigar-shaped object neatly made from the columella of a large marine univalve (Fig. 10); a columella wrought to a cutting edge at one end.

With burials were: a chert arrowhead and a shell drinking cup with perforate base; an arrowhead, of chalcedony; a conch-shell and several sherds; a shell drinking cup without the basal perforation; two ornaments of shell (Figs. 11, 12).

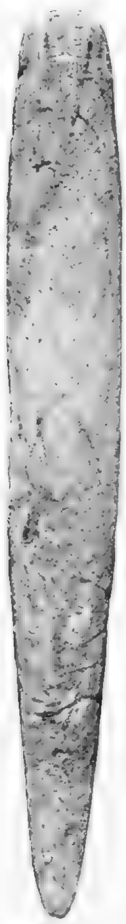


FIG. 10.—Cigar-shaped object of shell. Mound near Gigger Point. (Full size.)

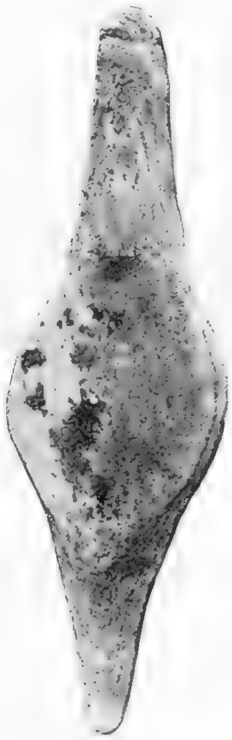


FIG. 11.—Pendant of shell. Mound near Gigger Point. (Full size.)

FIG. 12.—Ornament of shell. Mound near Gigger Point. (Full size.)

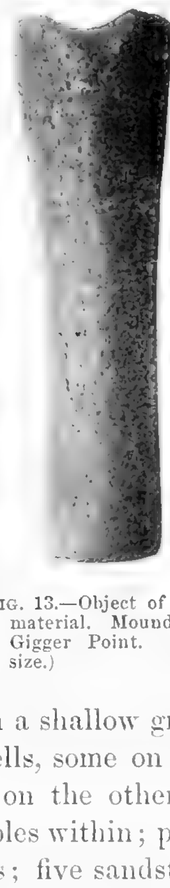


FIG. 13.—Object of fossil material. Mound near Gigger Point. (Full size.)

With a skeleton in a shallow grave were several mussel-shells, some on one side of the skull, some on the other; a turtle-shell with no pebbles within; parts of a conch-shell or shells; five sandstone hones; a fragment of chert; a mass of chert, about 2 inches in diameter, chipped into a circular shape; one smoothing stone; the end of an implement of bone; a small mass of serpentinous rock; two nodules of hematite; two silicious clay pseudomorphs; a bit of sandstone.

With another burial were: a bit of earthenware; mica given the outline of an arrowhead; an ellipsoidal pendant of igneous rock, with one end grooved and partly covered with bitumen, the other end broken.

An unidentified object of fossil material (Fig. 13) we are confident came from this mound, though we do not find it described in our field-notes.

At the extreme margin of the northeast part of the mound, with a burial, were two vessels of earthenware, both of which have the mortuary perforation, with this difference that, instead of the usual knocking out of part of the base, or of all of it, a carefully rounded hole is present as though, after a piece had been broken out, the edges had been worked to give a symmetrical outline.

One of these vessels had four roughly circular compartments around a larger circular one on a higher plane, almost exactly as shown in Fig. 268 of our second part of the report on the mounds of the northwest Florida coast. The vessel from the Gigger Point mound is covered with crimson pigment on the inside and on the upper half inch of the outer portion. The central compartment alone has the basal perforation.

The other vessel (Fig. 14), an oblate spheroid of about one gallon capacity, has a rather striking decoration consisting of seven encircling rows of wedge-shaped impressions between the rim and a circular band in relief.

There were in the mound, also, here and there, a moderate number of sherds, including one example of the small check-stamp, three or four of the complicated

FIG. 14.—Vessel of earthenware. Mound near Gigger Point. (About two-thirds size.)

stamp, one with ornamentation apparently made by impression of a finger-nail, and a small portion of a graceful vessel of excellent ware covered with crimson pigment, inside and out, and ornamented in places with fine, punctate markings.

One fragment of earthenware in this mound had a mingling of white material, here and there, giving it the appearance of shell-tempered ware. Expert examination, however, showed it to be pounded lime-stone, probably, since it was largely carbonate of lime, and showed no lamination under the glass. Shell-tempered ware is very unusual in Florida at any distance from Alabama where that ware was used. The material of which we speak, however, also, is exceptional in pottery of the peninsula.

Mounds near Dry Creek, Levy County.

Dry Creek enters Waccasassa bay about three miles to the westward of Waccasassa river. By following the course of the creek about 1.5 miles through the salt marsh, the Gulf Hammock is reached. The territory thus known is a strip of hammock land of varying breadth lying back of the salt marsh which borders the Gulf. between the Suwannee and Withlacoochee rivers.

Following a road entering the hammock, about .75 of a mile, we came upon a mound by the road-side, on property of Mr. Arthur T. Williams, of Jacksonville, Florida, about 2 feet high and 25 feet across the circular base. On the mound was a giant live-oak. We were unable to find either bone or artifact in this mound, in which there had been much previous digging.

About 300 yards farther along the road is an "old field," fallow for years. In this field, bordering a pond, is a mound 34 feet across the base and about 2.5 feet in height, also on property of Mr. Williams.

The mound, which was dug through by us about as extensively as a great oak growing upon it permitted, was composed of black loam from the nearby swamp. In this were masses of lime-rock similar to many in the surrounding field.

Many human bones, probably scattered by the plough, as the mound had been under cultivation, were met with by us, also three flexed skeletons and a number of bones of lower animals.

Mound near Burns' Landing, Levy County.

Burns' Landing is about seven miles up the Waccasassa river. Following a road leading into the Gulf Hammock from the landing, about 1.5 miles, we came to a small mound in sight of the road. This mound, about 25 feet in diameter and 18 inches in height, at the time of our visit, had been so thoroughly dug through that no work by us was attempted.

Mound near Bear Landing, Levy County.

This mound, about 200 yards in a northerly direction from the landing, which is about six miles up the Withlacoochee river, following the course of the stream, was in hammock land near the edge of the pine woods, on property of Mr. W. R.

Hodges, of Cedar Keys. The mound was literally honeycombed with pits and trenches, some of which, as we discovered, had been dug a second time, material from one trench filling a former one, which had again been dug by later disturbers. In fact, a strip on one side of the mound and a small portion near the base, at the center, were the only undisturbed parts. Trees growing near the top, by exposed roots, showed the mound to have been, at one time, about 2.5 feet higher than at the time of our visit when its height was about 3 feet. Its basal diameters were 58 feet by 45 feet.

The mound, new material and old, was dug through by us to the lime bed-rock found in these parts, with the exception of small portions around three trees.

Thirty-two undisturbed burials were met with by us. Twenty-eight were of the bunched variety. One skull lay with part of an ulna. One skeleton was closely flexed on the right side and two were closely flexed on the left side. One of these lay in a shallow pit, the only one met with in the mound, and had above it dark sand with scattered oyster-shells. All bones were badly decayed and no skulls were preserved. Large fragments, however, showed no cranial flattening.

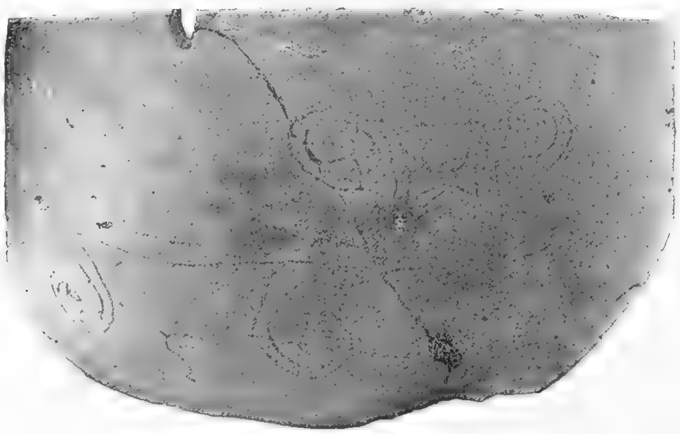


FIG. 15.—Part of vessel of earthenware. Mound near Bear Landing. (Half size.)

With burials were some bits of pot, in one instance, and a "waster" of chert, in another. There were also in the mound two flakes of chert, evidently used as knives; one clam-shell; several small masses of lime-rock; a pebble with one end smoothed, as by use as a polisher; one pebble-hammer; two chert arrowheads found separately; two clam-shells with depressions at opposite sides, as for a handle.

In the SW. margin of the mound, placed in the lower part of an undecorated vessel of inferior ware, was a bowl which fell into fragments upon removal, a part having been crushed by roots. On one side of this bowl, rudely done, was part of an incised design, as though the decoration of the bowl had been started and abandoned (Fig. 15). Near this bowl were various scattered fragments of inferior ware. Two feet away was a burial.

There was also in the mound various undecorated sherds, and fragments constituting the upper part of a bowl with thickened rim, which had been decorated with red pigment.

Mound near Rock Landing, Citrus County.

Crystal river is the output of a great spring about seven miles, by water, from the Gulf.

Rock Landing is about 3.5 miles from the mouth of the river.

In scrub, about 1.5 miles in a NE. direction from the landing, on property under control of Mr. R. J. Knight, of Crystal River, was a mound 3 feet 3 inches in height, with basal diameters ef 40 and 50 feet.

Thorough investigation showed this to have been a domiciliary mound.

Mound near the Shell-heap, Crystal River, Citrus County.

In full view from the river, about 4.5 miles from the mouth, on the left-hand side going up, is a great, symmetrical shell-heap, on property under control of Mr. R. J. Knight, of Crystal River.

This shell-heap, marked A on the plan (Fig. 16) is 28 feet 8 inches in height, is oblong in horizontal section and has basal diameters of 182 feet NW. and SE. and 100 feet NE. and SW. The summit plateau is 107 feet and 50 feet in the same directions, respectively. A graded way 80 feet long and from 14 feet to 21 feet across, ascends from the level ground to the summit plateau on the NE. side of the mound.

Beginning at the NW. corner of this mound is a low, irregular shell deposit, marked B on the plan, extending to the northward then curving to the eastward and extending for a distance along the river bank.

About 115 yards in a northerly direction from the great shell-heap is a circular embankment of sand, marked C on the plan, of irregular height and width, the maximum, respectively, being 6 feet and 75 feet. Within this circle is certain territory on the general level, marked D on the plan, and an artificial elevation of sand, irregularly sloping (E). This elevation culminates in a mound of sand, marked F on the plan. While difficult to determine where the artificial elevation ended and the mound proper began, to call the diameter of the base of the mound 70 feet, would be a fairly correct estimate. The height of the mound proper from the east, where it bordered the level ground, was 10 feet 8 inches. Cross sections of the elevated ground and the mound proper are shown in Fig. 17.

In a northerly direction from the circular embankment are two ridges of shell, one (G) low and irregular, the other (H), 12 feet in maximum height, with a graded way.

Certain excavations made in the level ground outside and inside the circular embankment, yielded negative results.

Excavations in the embankment showed burials in the southerly portion where the embankment was highest and one burial in the western part. Our work, however, on the level ground and in the embankment was not exhaustive.

Eighteen men, with four men to supervise, dug seven days, demolishing the entire mound and going through much of the elevated ground surrounding it. The

FIG. 16.—Plan. Mounds, shell-heaps and causeway. Crystal river.

Fig. 17.—Plan and elevations Place of burial. Crystal river.

work done by us is shown in broken lines on plan (Fig. 17), where, however, many small excavations made in the level ground and in the embankment are not given.

Though the shell-heap on Crystal river is a famous one, the sand mound was unknown to the inhabitants of the town of Crystal River, even the owner being unaware of the existence of this mound. Absolutely no digging had been done previous to our visit, which is a most important feature, and especially so when we note the interesting objects found by us and the fact that no object indicating European provenance was met with throughout the entire investigation.

In the artificial elevation, burials were very numerous, and to so great an extent had the ground been used that many graves, passing through earlier ones, had caused great disturbance. In addition, numbers of disconnected bones lay, here and there, in the sand as though they had been gathered from the dead-house and scattered while the making of the elevation was in progress. Hence, exact classification as to form of burial was impossible, nor could any estimate be arrived at as to the number of individuals originally interred, as all bones met with were so decayed that the skulls were often in small fragments. Our enumeration of burials, that is of where bones were encountered, certainly falls far short of the number of individuals interred.

The mound proper, of gray sand in the upper part and of white sand in the lower, had, running through it, along the base, from the eastern margin to the center, approximately, a ledge of shell about 2 feet high and 20 feet broad. This ledge seemed to have no particular connection with the burials.

Running for a distance of many feet into the mound were several streaks of sand dyed with hematite. One, in the southern part of the mound, from 2 to 8 inches in diameter, especially persistent, extended from the outer slope to the center. The intensity of the coloring varied considerably.

There were also pockets of scarlet sand, but these were local and in connection with burials. Once a pocket of scarlet sand was associated with sand dyed yellow by powdered limonite.

What has been said as to the difficulty of count and of classification of the burials in the elevated ground applies equally to the mound though from a different cause, in part. While burials in the mound were not unusually numerous, the height of the mound and the extreme dryness of the sand of which it was built, caused much caving and consequent disarrangement of burials.

In the elevation and in the mound, were about 225 burials, including:

Bunched burials,	42
Full length on back,	63[1]
Closely flexed on the right side,	31
Closely flexed on the left side,	26
Partly flexed on the right side,	2
Partly flexed on the left side,	7
Lone skulls,	11
Skeletons of infants, badly decayed,	7

[1] Four of these lay side by side in a single grave; seven had lower extremities cut off by later interments.

Special burials not included in the above were as follows:

Two skulls, a femur and a radius.

Four skulls with two long-bones.

Three skulls and scattered bones.

A skeleton without pelvis or lower extremities. Beneath the place where the pelvis should have been was another skull, probably an aboriginal disturbance.

Two skulls with scattered bones.

Four skulls with scattered bones and, nearby, the lower extremities of a skeleton. In place of the pelvis was a skull and beneath it another skull.

A skeleton lying on the back with the legs flexed upward.

Three skulls and one humerus.

In a grave was the skeleton of a child at full length on the back and another child's skeleton lying flexed to the left. Above these were many oyster-shells and numerous masses of lime-rock, from 3 to 8 inches in diameter.

A bunched burial with four skulls.

Various unclassified burials.

In the elevated ground surrounding the mound, masses of oyster-shells almost invariably lay above the burials and sometimes extended well to the sides. To this rule there were but three exceptions.

In the mound proper, on the other hand, forty burials unassociated with oyster-shells were noted, though there, also, many burials were covered by them.

While no crania were in a condition to save, parts of many showed no cranial flattening.

Many of the bones bore marks of pathological lesions.

Artifacts were very numerous in the elevation and in the mound, though those from the mound proper were of much higher grade, as a rule, than were the artifacts from the sloping ground around it. There was no general deposit of earthenware or of other objects. While certain artifacts were found unassociated, there was every indication that most of them had lain with burials which had suffered aboriginal disturbance.

In this place of aboriginal abode it was evident we were no longer among the mounds of the northwest Florida coast, with their great deposits of earthenware placed for the dead in common, in the eastern part of the mound. Here the vessels were widely scattered and were found singly. Outside the mound but few vessels were met with, though little piles of sherds, bits of inferior ware from various vessels, were numerous.

There were present in the elevated ground, as well as in the mound, a limited number of sherds bearing the complicated stamp, the design being chiefly one of concentric circles, a popular pattern along the central west-coast of Florida, and which we found in the great shell-heap at Cedar Keys.

From the mound proper came a number of vessels, some of inferior ware, others of excellent material.

The most striking object in earthenware met with during the investigation is

part of a cylindrical vessel (Fig. 18) of excellent ware, bearing an incised design showing part of the human hand, remarkable for its boldness of execution. On the back of the hand is a curious figure which many authorities agree is not a known totemic symbol or design of any sort, hitherto met with. Some have suggested its origin from heraldry and hence early European sources, while a still greater number see nothing in the design that suggests other than an aboriginal origin. To us the figure has an aboriginal look, and as nothing of European provenance was met with during our investigation of the mound--and this counts for so much in determinations—we believe the symbol to be aboriginal in origin. Other designs, perhaps equally interesting, have been on the remainder of the vessel, which a diligent search failed to discover.

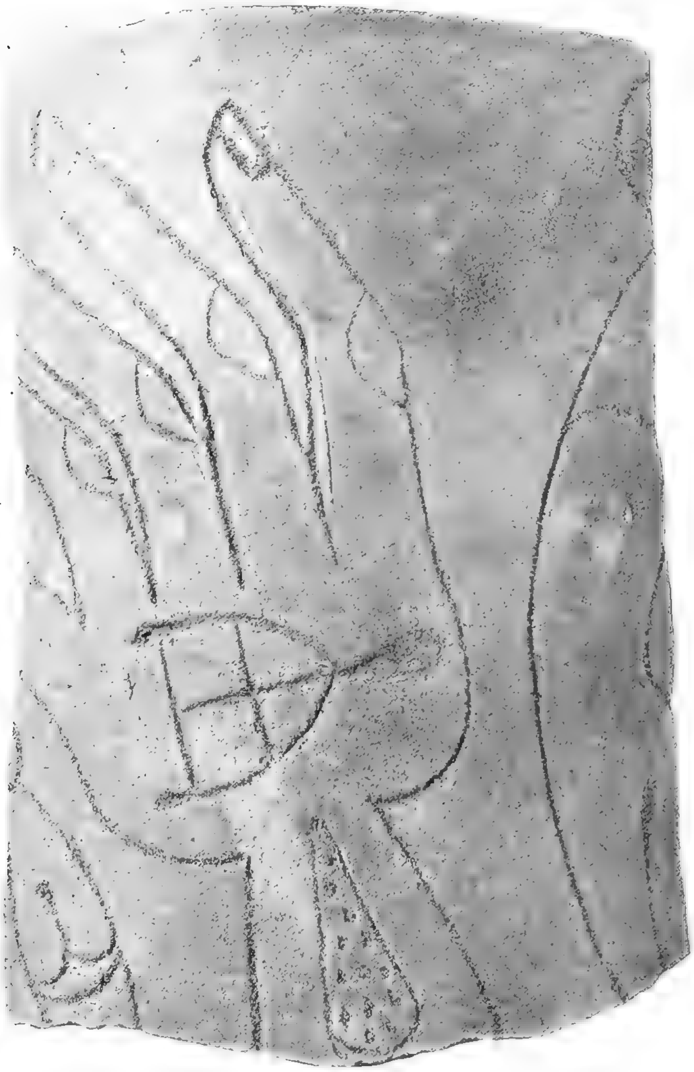


Fig. 18.—Sherd. Mound near Crytal river. (Full size.)

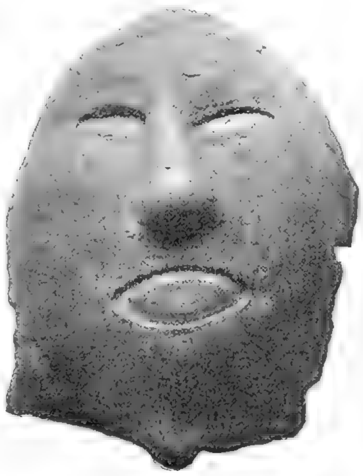


Fig. 19.—Part of earthenware vessel. Mound near Crystal river. (Full size.)

Throughout the mound were vessels with feet, and parts of vessels indicating the presence of feet when the vessels were whole. There was also found a part of a vessel, showing a human face (Fig. 19).

A selection of sherds found during the investigation is given in Fig. 20. The third from the left hand upper corner shows punctate decoration between bands of crimson pigment. The sherd in the lower right-hand corner has part of another open hand.

We shall describe the vessels in detail.

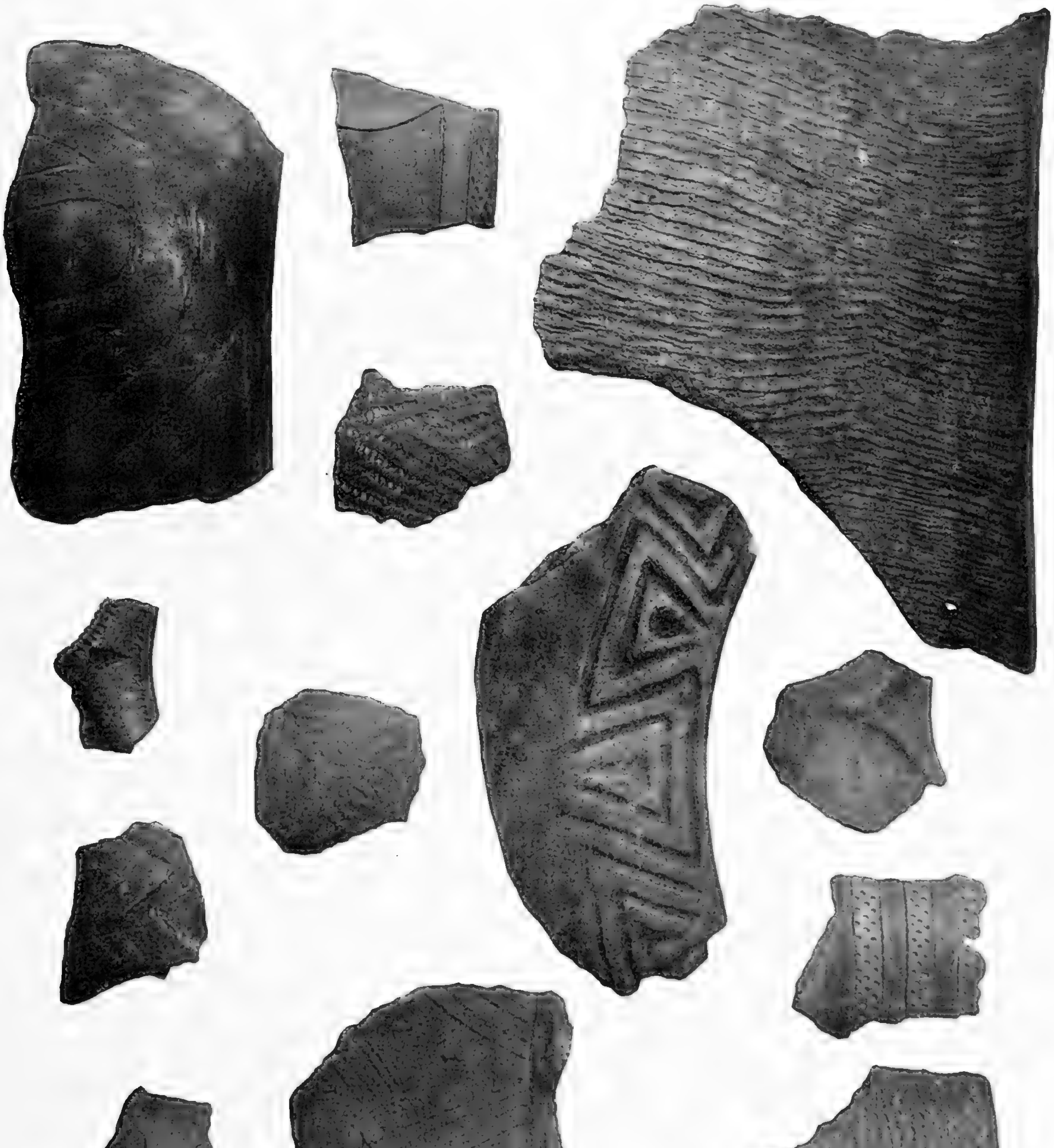


Fig. 20.—Selection of sherds. Mound near Crystal river. (Half size.)

Vessel No. 1.—An oblate spheroid, of good ware (Fig. 21) lay with a burial in the northwestern border of the artificial elevation. It is entirely covered with incised and punctate decoration shown diagrammatically in Fig. 22 where the cross on the base of the vessel is spread in order to show the design in diagram. This cross is given with the remainder of the basal decoration in Fig. 23. There are two holes for suspension in the vessel, and the usual mortuary perforation.

FIG. 21.—Vessel No. 1. Mound near Crystal river. (Full size.)

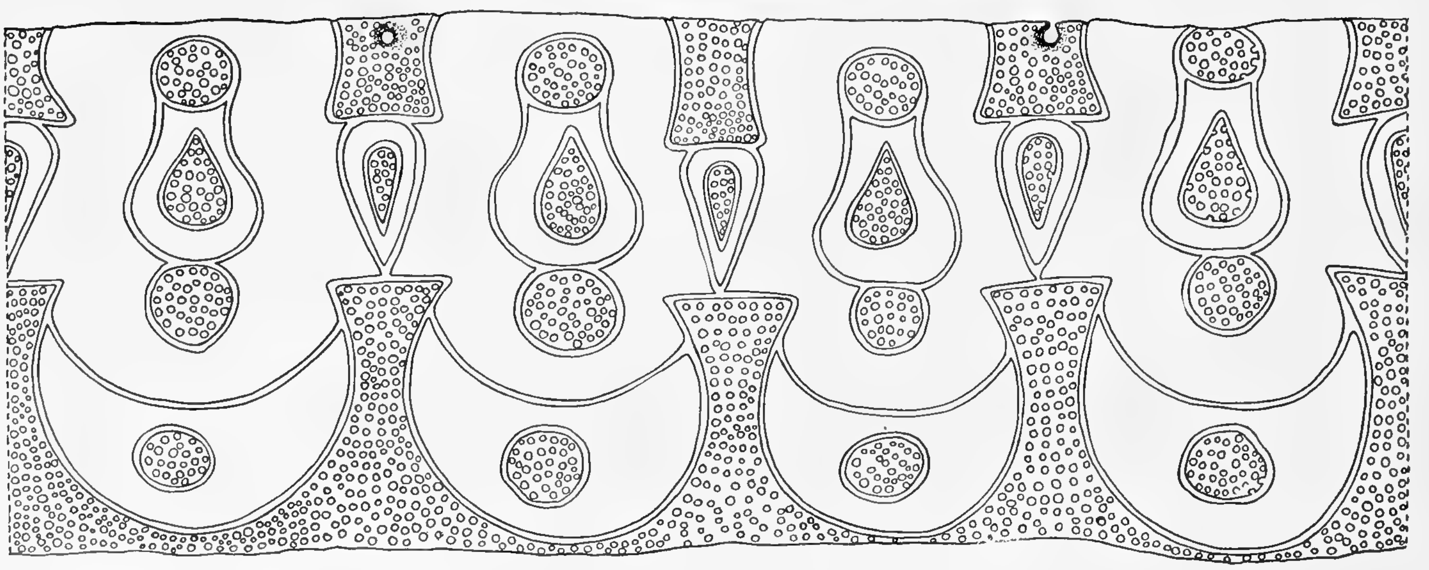


FIG. 22.—Vessel No. 1. Decoration. Mound near Crystal river. (Half size.)

Vessel No. 2.—An undecorated bowl, of most inferior ware. There is a small basal perforation, which is the case with all vessels in this mound unless otherwise described.

Vessel No. 3.—A broken bowl of inferior ware, undecorated.

Vessel No. 4.—Similar to Vessel No. 3.

Vessel No. 5.—This vessel, of dark ware, which lay about one foot from the skeleton of an infant, had with it a small, imperforate, shell drinking cup. The basal perforation had carried away two of the feet which have since been restored and a certain amount of restoration has been done to the rim. The interior of the dentate design has been colored with red pigment (Fig. 24).

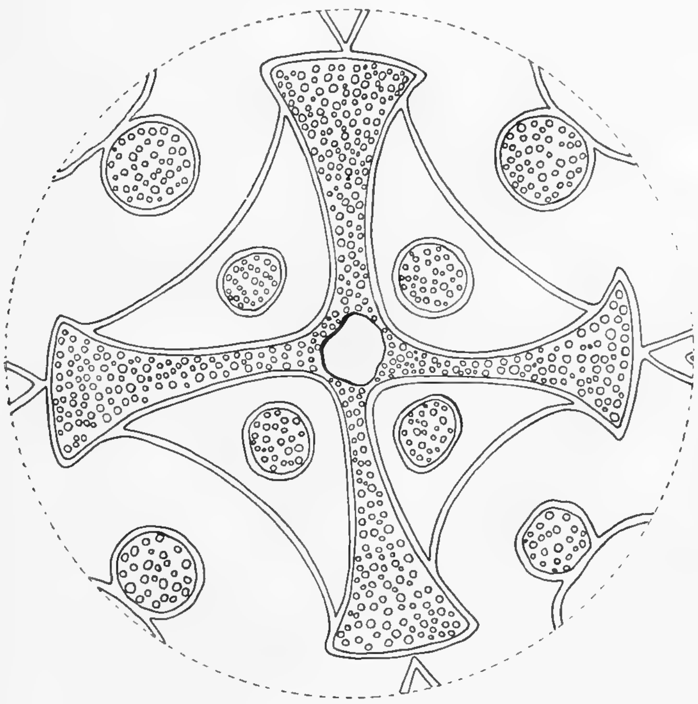


Fig. 23.—Vessel No. 1. Decoration of base. Mound near Crystal river. (Not exactly on scale.)

Fig. 24.—Vessel No. 5. Mound near Crystal river. (Full size.)

Vessel No. 6.—An undecorated, cylindrical jar of about one quart capacity, slightly contracted toward the base, which is flat and imperforate.

Vessel No. 7.—A toy pot of poor ware, undecorated save for notches around the margin. Two holes for suspension, on opposite sides, have been enlarged by the pulling through of the cord or sinew used. There is a carefully broken circular hole in the base. This little vessel has six feet, one somewhat within the line of the other five.

Vessel No. 8.—A bowl of excellent ware, with protruding rim (Fig. 25).

Vessel No. 9.—This vessel, undecorated, of excellent ware, lay with bones in the mound proper whence came all vesels yet to be described. In shape it is a much flattened sphere. There is a carefully rounded hole in the base and small holes for suspension on opposite sides of the opening.

FIG. 25.—Vessel No. 8. Mound near Crystal river. (Half size.)

Vessel No. 10.—A small, imperforate, undecorated bowl.

Vessel No. 11.—A pot of inferior ware, badly broken by roots, having traces of red pigment, and rough incised decoration similar on two opposite sides.

Vessel No. 12.—In fallen sand was an undecorated, imperforate vessel with ovoid body, flat base, and flaring neck, broken but since cemented together (Fig. 26).

Vessel No. 13.—A bowl of about one quart capacity, of beautiful, smooth, red ware, with thickened rim projecting slightly, horizontally (Fig. 27). The decoration, in black pigment, was not continued around the vessel, or has disappeared through wear.

FIG. 26.—Vessel No. 12. Mound near Crystal river. (Full size.)

FIG. 27.—Vessel No. 13. Mound near Crystal river. (Two-thirds size.)

Vessel No. 14.—The upper part of a vessel of beautiful red ware, with certain lower portions decorated with bands of black pigment (Fig. 28), which would give quite a classical appearance were it not for the scalloped rim.

Vessel No. 15.—Unassociated in the mound, was part of a curious vessel originally annular in shape. On the fragment is one upright neck and parts of two others. The vessel, when whole, probably resembled that shown in Fig. 164 in Part II of our "Aboriginal Remains of the Northwest Florida Coast," though in this case the body of the vessel is not flattened.

FIG. 28.—Vessel No. 14. Mound near Crystal river. (About two-thirds size.)

Vessel No. 16.—A vessel, badly broken, originally with four feet, two of which were lost at the time of the basal mutilation (Fig. 29). These feet, with certain parts of the body, have been restored.

Vessel No. 17.—A vessel of excellent ware, undecorated save for the scalloped rim. At the base, which is rounded, has been a flat, circular space in relief, 1.25 inches in diameter, which enabled the vessel to stand upright. A circular perforation has been made through this flattened part (Fig. 30).

Vessel No. 18.—A rough, undecorated vessel.

Vessel No. 19.—A wide-mouthed water-bottle, undecorated, with a portion missing.

Fig. 29.—Vessel No. 16. Mound near Crystal river. (Two-thirds size.)

Fig. 30.—Vessel No. 17. Mound near Crystal river. (Full size.)

FIG. 31.—Vessel No. 20. Mound near Crystal river. (Two-thirds size.)

Vessel No. 20.—This interesting vessel, a bowl, of superior ware, of about two quarts capacity (Fig. 31), has had for decoration a design in black pigment which, apparently, having grown faint in course of time, has had painted above it designs

FIG. 32.—Vessel No. 21. Mound near Crystal river. (Full size.)

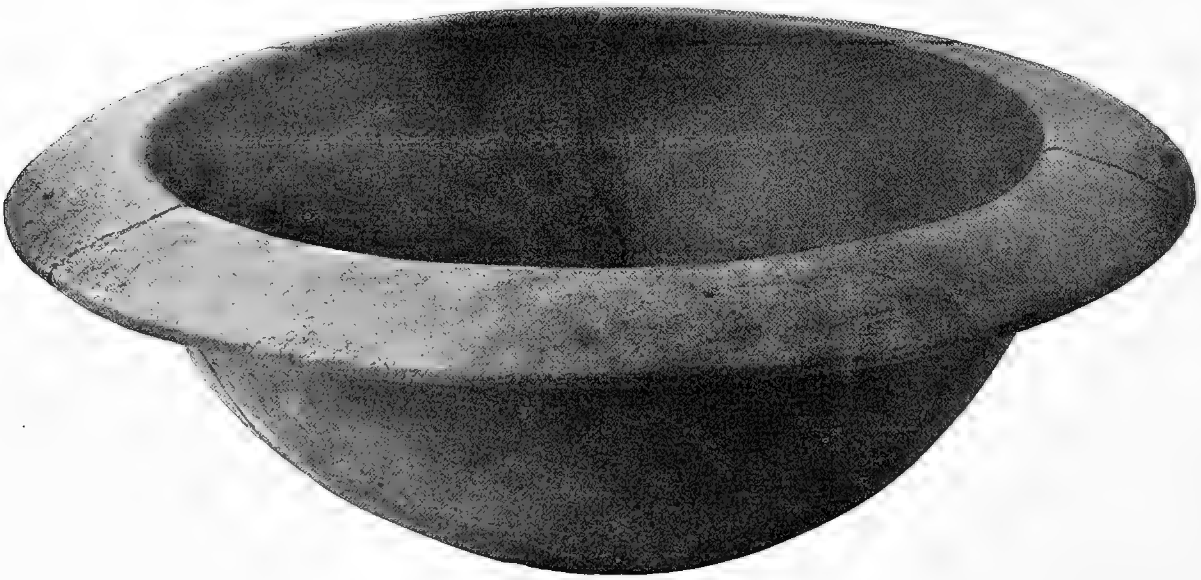


FIG. 33.—Vessel No. 22. Mound near Crystal river. (About five-sixths size.)

FIG. 34.—Vessel No. 23. Mound near Crystal river. (About three-fourths size.)

in two shades of red. Our artist has well shown in stipple the design in black, and in lighter and darker "wash," the two shades of red. The lightest shade of all on the vessel, of course represents the natural shade of the ware. About one-third of this vessel was missing when found. There has been restoration of the missing part, but no attempt to replace the complicated design.

Vessel No. 21.—Undecorated, save for four repoussé lobes each ending at the base in a foot for the vessel's support (Fig. 32).

Vessel No. 22.—An imperforate bowl of excellent ware, undecorated. A thick rim projects laterally (Fig. 33).

Vessel No. 23.—A vessel of about three pints capacity, with a neck, first constricted, then expanded. The decoration consists of a small check-stamp. One of four feet, missing through basal perforation, has been restored (Fig. 34).

Vessel No. 24.—A vase with rude, incised and punctate decoration, shown in Fig. 35.

Vessel No. 25.—Of inferior ware, undecorated, with semi-globular body, and long neck first constricted, then flaring.

FIG. 35.—Vessel No. 24. Mound near Crystal river. (Full size.)

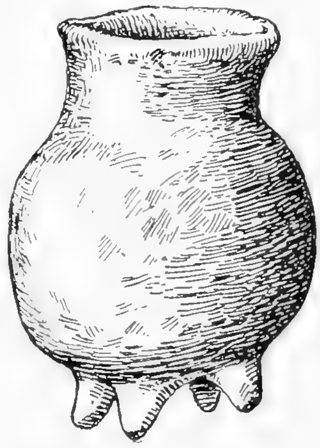


FIG. 36.—Vessel No. 26. Mound near Crystal river. (Full size.)

Vessel No. 26.—A toy vessel, undecorated, imperforate, with four feet, shown in Fig. 36.

A sherd from this mound is shown in Fig. 37.

Seven smoking pipes, all or nearly all from the mound proper, were met with during the investigation. Three are of soapstone, all of the familiar type with rectangular cross-section of the part having the bowl and of the part holding the stem. One of these pipes, showing faint incised decoration, is shown in Fig. 38. At the base of the bowl is a small circular orifice. In the second part of our "Certain Aboriginal Remains of the Northwest Florida Coast," page 256, we speak of a pipe with a basal perforation.

A rude pipe of earthenware, also of common type, has the bowl slightly flaring.

Part of a pipe of earthenware, similar in shape to those of soapstone, came from the mound. There was found also a small "Monitor" pipe of earthenware, somewhat broken. This is the first example of this type of pipe met with in penin-

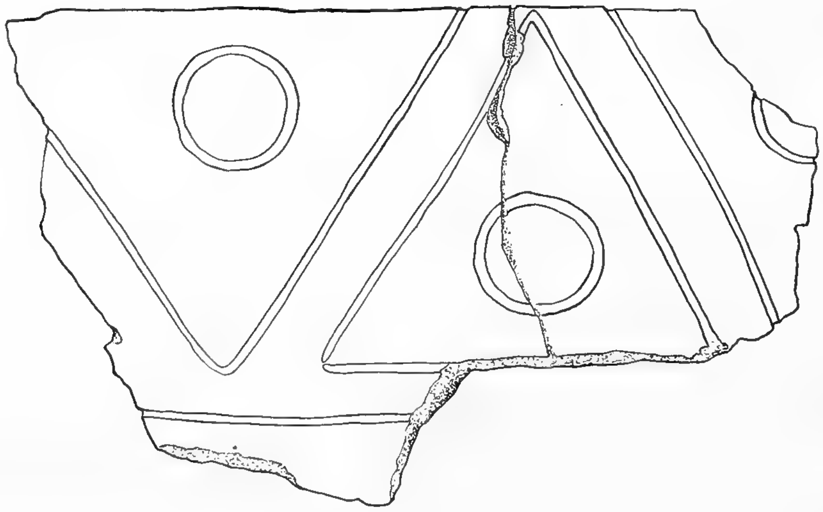


FIG. 37.—Sherd. Mound near Crystal river. (Half size.)

sular Florida. There was also in the mound a great pipe of soft lime-rock, found in pieces, but since restored. In shape it is the same as those of soapstone. Each arm is 5.5 inches in length. The measurement across each end is 2.25 inches; the openings are about 1.25 inches each, in diameter.

A flat tube of earthenware, perhaps used for a ceremony with smoke, came from the mound proper (Fig. 39).

Throughout the investigation were met with, in the elevated ground and in the mound proper, a large number of shell cups wrought from *Fulgur perversum*, some imperforate, but the great majority with the mortuary perforation. There were also eight or ten drinking cups made from what is known as the "horse-conch" (*Fasciolaria*) along the Florida coast. One of these cups is shown in Fig. 40. We do not recall before having met with a drinking cup made from this shell, although the shell was largely used in the manufacture of implements in aboriginal times.

One drinking cup wrought from *Melongena corona*, the first we have seen, was found during the investigation.

During our work, there were met with sixty columellæ of large marine univalves, sometimes a considerable number with a single burial. These columellæ had been at times ground squarely across one end to serve as chisels, and sometimes given a circular edge for use as gouges. Occasionally, a wing, or flange, was left to increase the gauge of the edge.

There were found also ten gouges made from triangular sections of the body-

Fig. 38.—Smoking-pipe of soapstone. Mound near Crystal river. (Full size.)

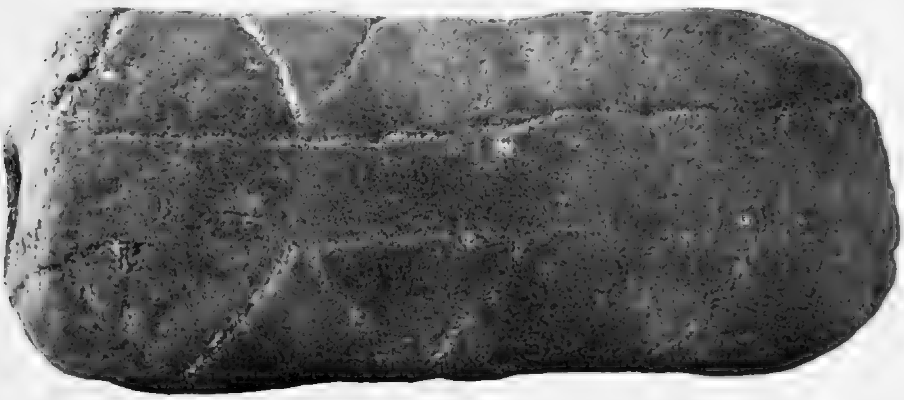


Fig. 39.—Tube of earthenware. Mound near Crystal river. (Full size.)

Fig. 40.—Shell drinking cup. Mound near Crystal river. (Two-thirds size.)

whorl of *Fulgur perversum* and one rectangular chisel likewise wrought from *Fulgur*, also seventeen "celts" made, as a rule, from the lip of *Strombus gigas*, 2.5 to 7 inches in length. All implements of shell from this mound were badly weathered.

Three large shells (*Cardium*) were met with, each with a hole in the centre to allow the insertion of a handle, and a number of large clam-shells, some showing wear. There were, also, triangular sections of clam-shells, doubtless tools, when hafted. Among the clam-shells was a large marine shell of the clam family (*Callista gigantea*).

There were found also three conchs (*Fulgur perversum*) variously treated for the reception of handles, and worn down at the beak by use as hammers, hoes, etc.[1]

Eleven gorgets wrought from the body-whorl of *Fulgur perversum* came from the mound, almost invariably associated with other objects near burials or near where burials had been disturbed. Only one shows decoration and none is engraved.

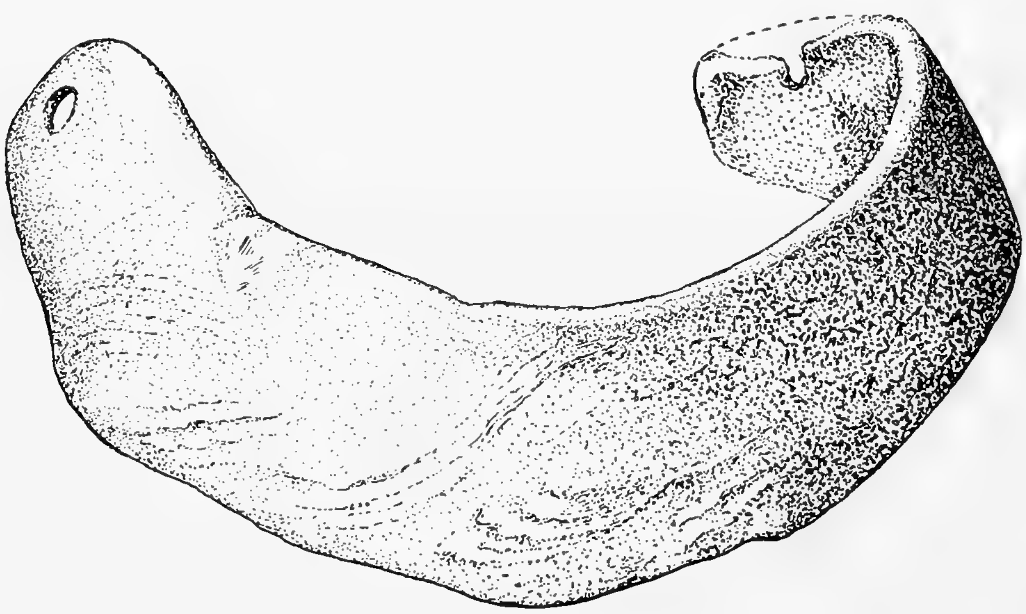


FIG. 41.—Gorget of shell. Mound near Crystal river. (Full size.)

Four are roughly circular, ranging in diameter from 2.25 to 3.5 inches. The smallest has a circular perforation in the center, about .12 of an inch in diameter. The next in size has, in the middle, three small holes in line. Two have single holes centrally, one, in addition, having two perforations side by side, at the margin. Four others are sections of the body-whorl of *Fulgur*, scoop-shaped, each with a central perforation, three about 1 inch in diameter, the fourth much smaller. One, in addition, has two small holes side by side on the broadest portion. One of these gorgets lay with the concave side upon a skull.

Two gorgets, one a curved band of shell, about 1.5 inches wide, having a hole

[1] For description and figures of many implements of this sort, see our "Certain Antiquities of the Florida West-Coast," page 380 *et seq.* Journ. Acad. Nat. Sci., Phila., Vol. XI.

for suspension and showing where another has been (Fig. 41), the other, fragmentary, probably like the one just described, were found in the mound.

There was also a handsome little gorget with six rounded points, and a central perforation, shown in Fig. 42.

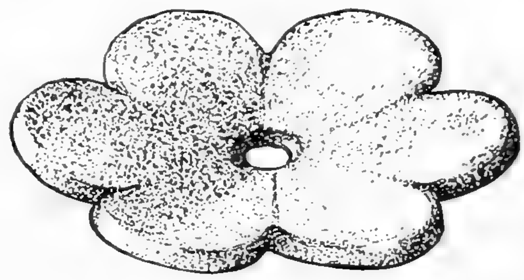


FIG. 42.—Ornament of shell. Mound near Crystal river. (Full size.)

A small number of shell beads were present with one burial, and with another were a discoidal bead of shell, about half an inch in diameter, and an imperforate shell disc of the same size. This scarcity of shell beads in a burial place teeming with objects of shell, is remarkable, and equally noticeable was the absence of shell hair-pins, which class of objects was represented by certain fragments of what may or may not have belonged to a hair-pin of shell.

Near the skull of a child, lay two shells pierced for suspension (*Oliva reticularis*, and *Cerithium*, a fossil, a large undescribed variety from oligocene beds).

Those who lay in the burial place near the great shell-heap had, in life, been given to the wearing of pendent ornaments—of shell, of stone, of copper.

Those of shell met with by us, 105 in number, were, as a rule, much affected by disintegration, and hence it is hard to say how finished their original appearance may have been. Doubtless they varied. On many is bitumen. One deposit, with a burial, consisted of ten pendants of shell, each about 5.5 inches in length. Another deposit of pendants consisted of one of lime-rock and five of shell, one being 9.25 inches in length. A selection of pendent ornaments of shell, found during the investigation, is shown in Fig. 43.

During the digging there were found : hammer-stones of chert, and several of quartz, fairly well rounded; pebble-hammers, including several of sandstone and pudding-stone; hones of sandstone and of ferruginous sandstone; flakes, and small, partly chipped, masses of chert; a "waster," of chert, 5.5 inches long; and various other fragments, and material of the class usually found in mounds. There were also fourteen entire "celts," of various rocks and a large number of "celts" badly broken. Some of these parts were afterward fitted together, which led us to believe that perhaps, also, these "celts" had been ceremonially broken before placing them in the mound. In length the "celts" varied from 2.5 to 12.5 inches. Incidentally, 13 inches is the greatest length of any "celt" met with by us in the south.

Thirty-one lance-points, arrowheads and knives, all of chert, were found during the digging, often associated with other objects. Many of these were rude, though a few were of excellent workmanship. In addition to these, from the same part of the mound whence came a number of "celts" in fragments, was a deposit of three lance-heads of brown chert, each broken in two parts; the lower half of a similar lance-head; two upper halves of lance-points of dark brown chert; three rude chert arrowheads, four chips of chert; the canine tooth of a large carnivore. Presumably the lance-heads in this deposit had been broken ceremonially.

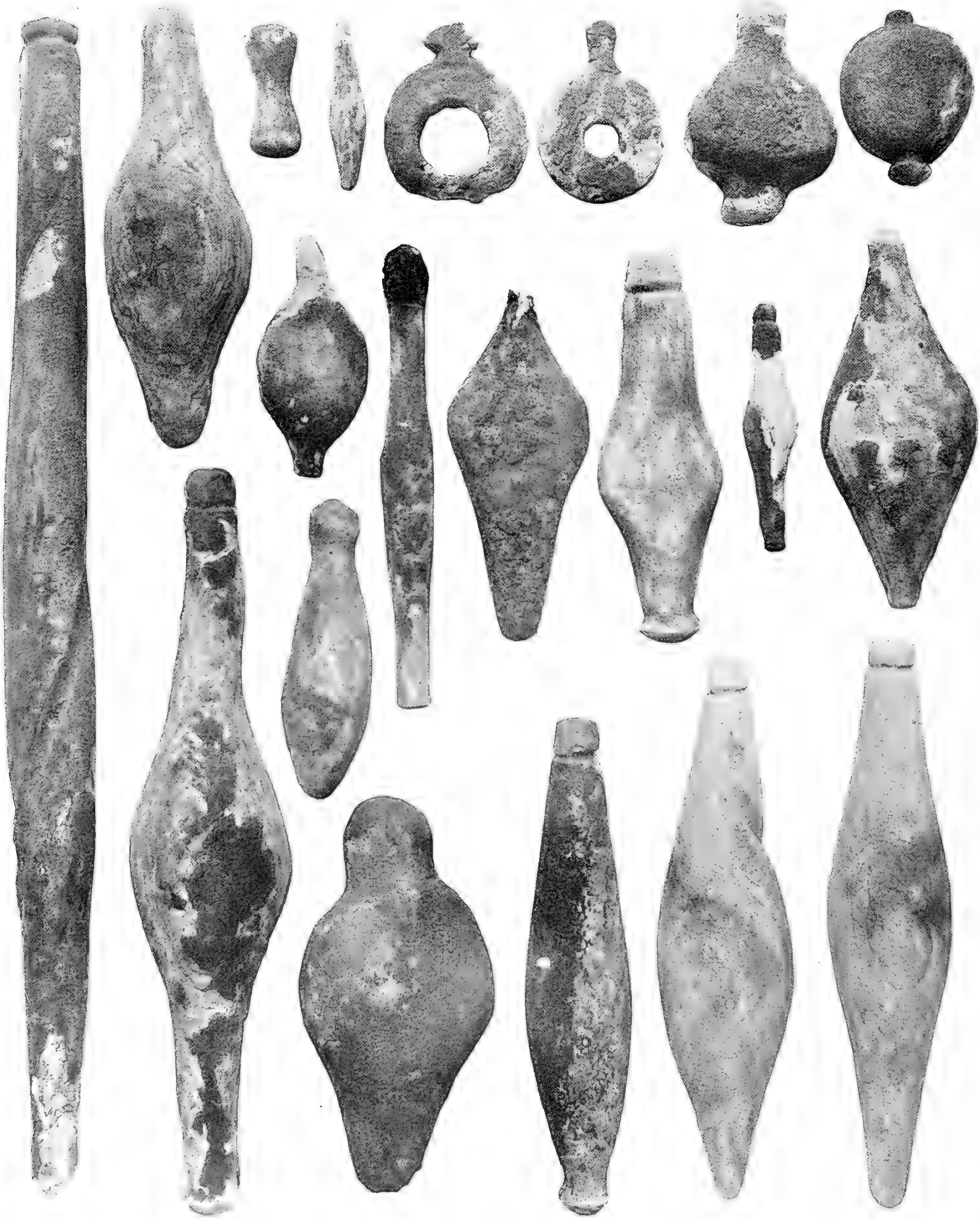


Fig. 43.—Selection of ornaments of shell. Mound near Crystal river. (Full size.)

A neatly made blunt-pointed implement of fossil material, from the mound, with incised decoration on one side, is shown in Fig. 44. Two cigar-shaped implements, also of fossil material, are given in Fig. 45.

Fig. 44.—Object of fossil material. Mound near Crystal river. (Full size.)

A carefully smoothed ellipsoidal hammer-stone of lime-rock, about 4 inches long, shows marks of considerable use. Two bar-amulets, one of lime-rock, one of thin, banded slate, came from the mound and many sheets of mica were found during the entire investigation. None of these had any particular shape and none was perforate.

One hundred and eleven pendent ornaments of various rocks were met with during the investigation. As mutilation of the specimens was not deemed advisable, there has not been an exact determination as to material. Many are of the lime-rock, and some, of the ferruginous lime-rock, of the district; others are of igneous rocks; two long ones are of slate. One is of calcite and doubtless there are other rocks not included in this enumeration. Several are of quartz, including two beautifully made of rock-crystal, one of which has, presumably, a conventionalized bird-form (Fig. 46).

Fig. 45.—Objects of fossil material. Mound near Crystal river. (Full size.)

Ten well-made pendants, shown in Fig. 47, lay with a burial with which was sand dyed with hematite.

A selection from the various stone pendants found by us is given in Figs. 48, 49, 50, 51, among which are shown a long slate pendant similar to those found by us the preceding year along the northwest coast, one pendant with a central perforation, and several doubtless intended to represent conventionalized birds.

On the base of the mound, in the southern slope, was the skeleton of an adult, lying full length on back. Extending across the pelvis, sagging down somewhat, was a row of pendants of stone, among which were three of copper, 4.7 inches, 5.75 inches, 6 inches long, respectively, of the same type as the long ones of slate from this mound, one of which has already been figured. Seemingly, all these pendants had hung from the waist in the manner shown by Le Moyne on aborigines of the St. Johns river, Florida. Along the lower part of the left arm, which lay extended down the left side of the body, were other pendants, or charm-stones, which may have fallen over from a belt at the waist. Exclusive of the copper, 39 pendants,

mostly of lime-stone and of ferruginous lime-stone, and a long one of slate, were in this interesting deposit. With them were two parts of the lower jaw of a puma, each with three molars, and each part having a hole artificially made near the foramen to aid in suspension or attachment. With these were two canines of a black bear, having the bases much ground away, and two molars, also of the bear, ground down, not on the base alone, but on certain of the sides also.[1]

About 5 feet down, in the southern side of the mound, near a skull belonging to a bunched burial, were three quartz crystals and one twin crystal of quartz, from 2.5 to 4 inches in length. The three crystals have grooves for suspension as pendants. On the twin crystal no groove is apparent, though there are traces of bitumen, at one end, where a cord has been attached.

With the crystals were sixteen ornaments of various rocks, including a small pendant of amethystine quartz,[2] a perfect gem, a triumph of aboriginal endeavor, shown fourth from the left-hand side of the upper row in Fig. 52 where all this deposit is given.

Fig. 46.—Pendants of rock-crystal. Mound near Crystal river. (Full size.)

The rocks of which these ornaments are made, which include beads, imitations of canine teeth of carnivores, and other forms, are impossible to name with any certainty, without mutilating the specimens to obtain slides for the microscope. One is surely of banded, ferruginous slate; others are of catlinite; several resemble hematite in appearance, but are not this material since they make a mark too light in color upon porcelain and do not respond to the magnet. Others are of fine-grained, igneous rock.

[1] *Vide*, "Certain Aboriginal Remains of the Northwest Florida Coast," Part II, Journ. Acad. Nat. Sci., of Phila., Vol. XII, pg. 240 *et seq.*

[2] We are indebted to Mr. Warren K. Moorehead for the following details of the discovery of a pendant of amethyst found in 1898, in a grave at the mouth of the Wabash river, west side, southern Indiana, by Mr. Clifford Anderson, acting under instructions from Mr. Moorehead. About 150 burials were found in graves at this place, having with them pottery, pipes, copper objects, etc. The graves, 2 to 4 feet below the present surface, were not stone lined. According to Mr. Moorehead, they mark the northernmost extension of the southern (Missouri–Arkansas) type of pottery. Mr. Moorehead kindly sent the pendant for our inspection. It is of a deep violet, pear-shaped, and has a perforation for suspension. It is about the same size as ours, but it is much more rudely made, showing a scratched surface without polish. The catalogue number of this specimen is 15,400, Museum, Phillips' Academy, Andover, Mass.

FIG. 47.—Pendants of stone, found with a single burial. Mound near Crystal river. (Full size)

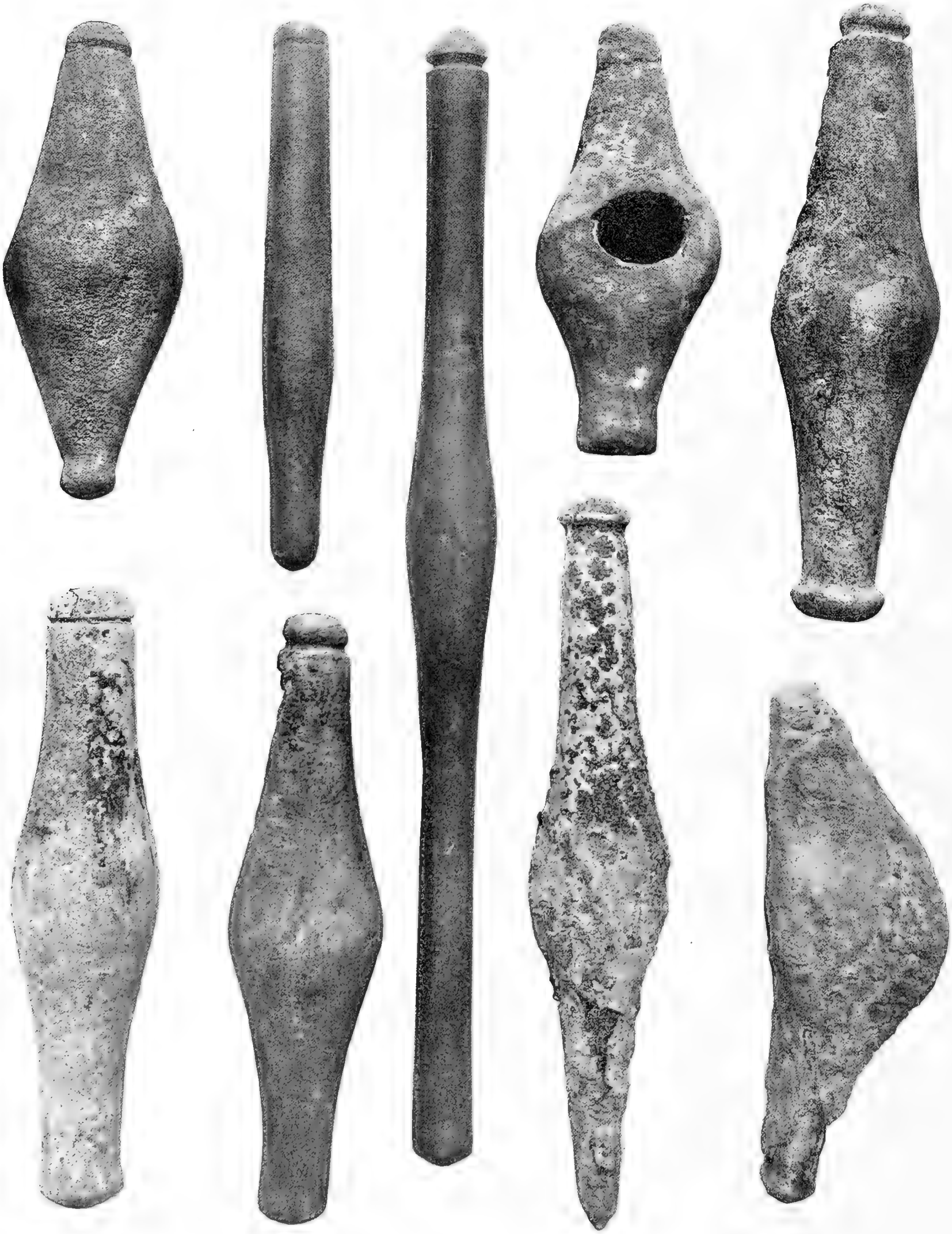


FIG. 48.—Selection of pendants of stone. Mound near Crystal river. (Full size.)

FIG. 49.—Selection of pendants of stone. Mound near Crystal river. (Full size.)

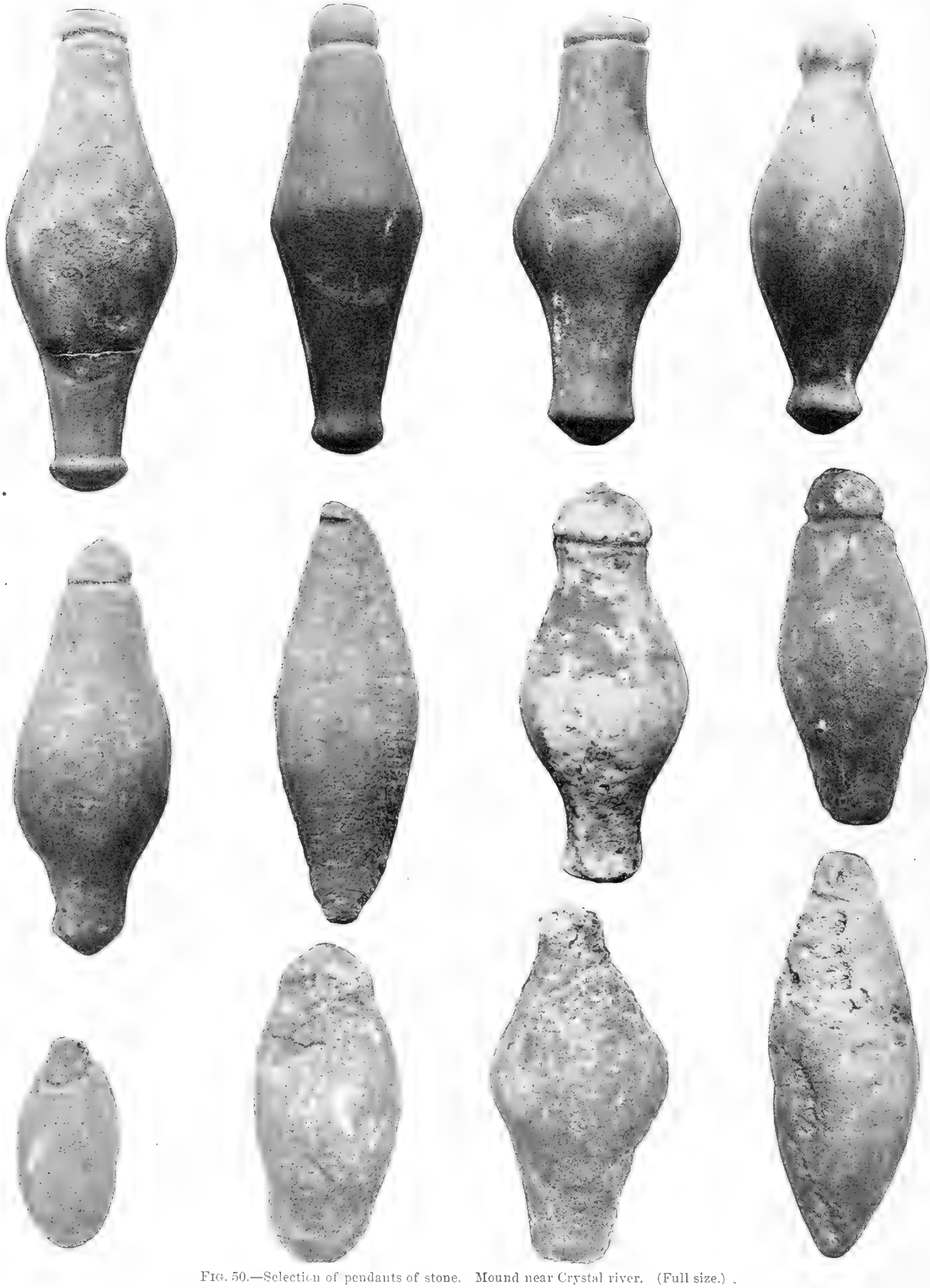


FIG. 50.—Selection of pendants of stone. Mound near Crystal river. (Full size.)

FIG. 51.—Selection of pendants of stone. Mound near Crystal river. (Full size.)

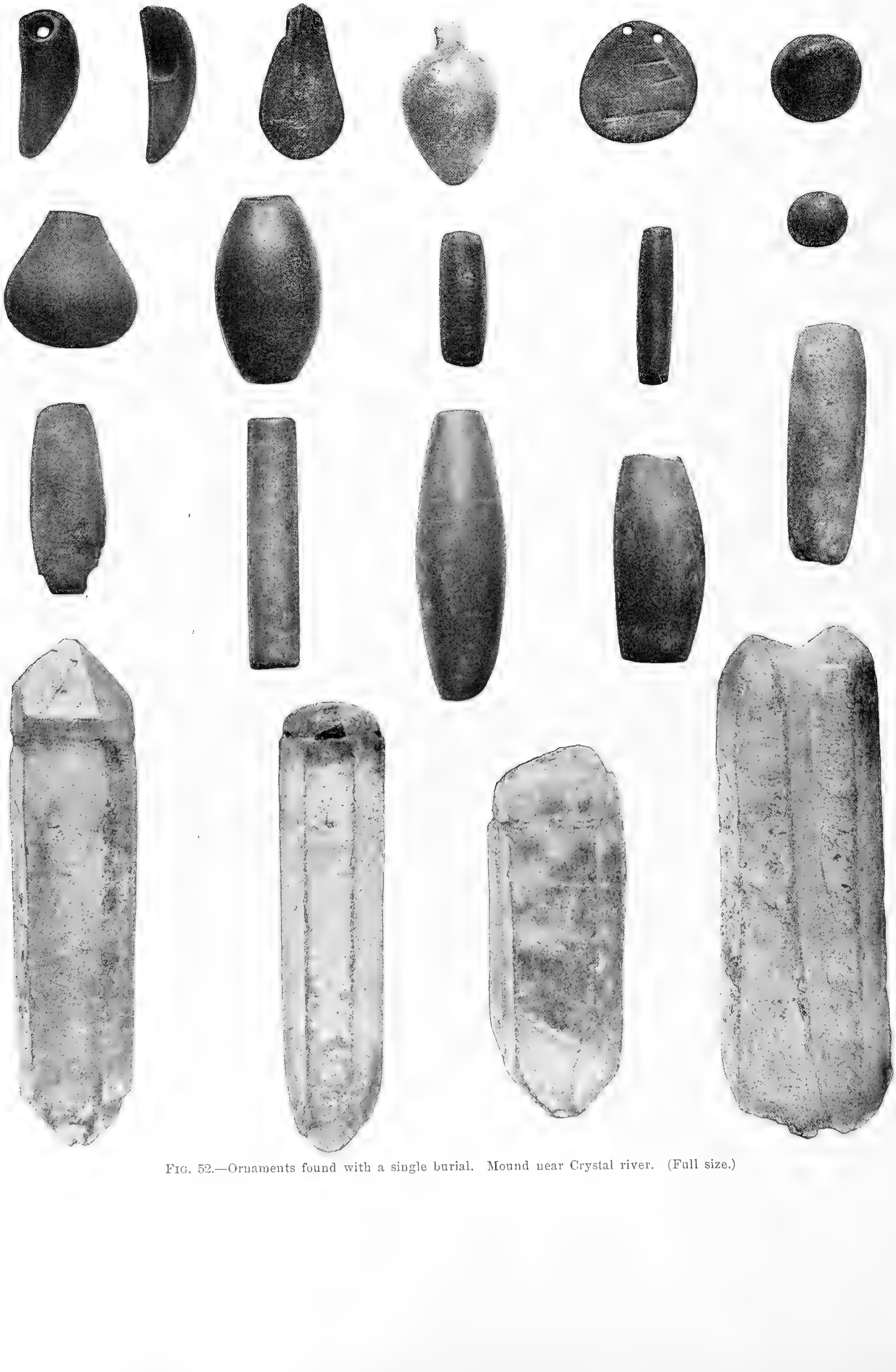


FIG. 52.—Ornaments found with a single burial. Mound near Crystal river. (Full size.)

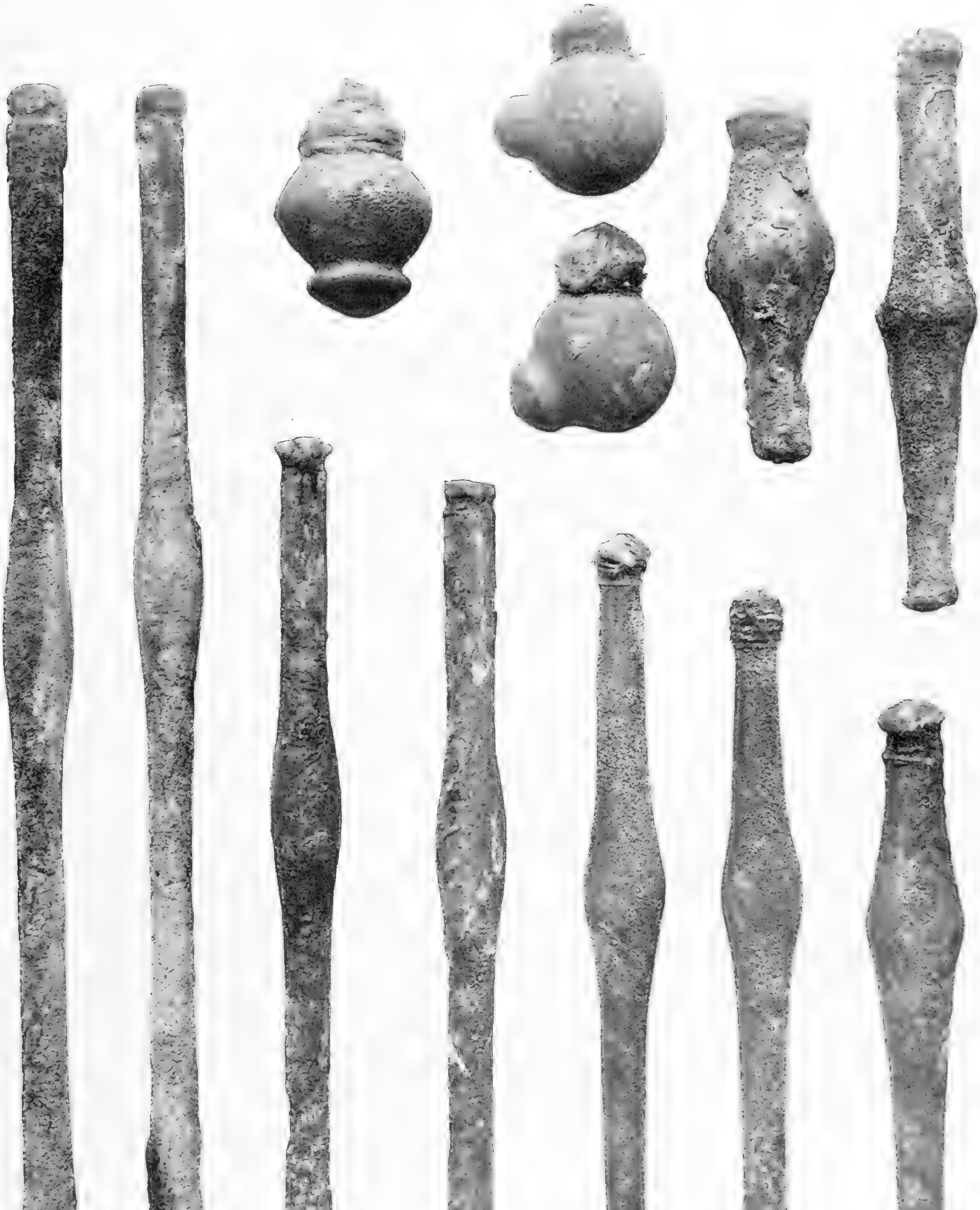


FIG. 53.—Pendent ornaments of copper. Mound near Crystal river. (Full size.)

The perforations in these ornaments are countersunk and from large openings at the surface meet at the center in a much smaller aperture. On some are scratches which probably would be called file-marks by those disbelieving in any proficiency obtained by the natives through ages of aboriginal culture, which marks are exactly similar to those noted on certain ornaments of red jasper found by us in Florida, on which material the file leaves no mark and which was no doubt worked with the aid of hard, cutting sand.

In the southern part of the mound, whence, with the exception of two copper pendants and the deposit of ten pendants of rock, came practically all articles of especial interest met with during the investigation, were found ten copper pendants, including the three already referred to, making twelve in all from this mound, shown in Fig. 53. Three pendants were twice found together, and three times, two pendants were in association, always, of course, with burials. All came from considerable depths in the mound, from 4 to 8 feet, and nearly all were wrapped in fabrics and in bark, as is customary with "finds" of copper.

An especially noteworthy feature connected with these pendants, which are of native copper, is that all are of the same type as other pendants of stone and of shell found in this mound, even the conventional bird-form being represented.

The method of wearing these pendants was interestingly shown. Apparently, certain material, seemingly hide, was cut into a small circle. A cord was run through the center of this and knotted on the lower side. The hide was then adjusted on the end of the pendant, like a cap, and the lower portion of the hide was bound around with a cord and fastened with bitumen. The cord which ran through the hide, when fastened to a belt, would allow the pendant to hang true, which it could not do had the hide not been used and a cord been tied around the end of the pendant and knotted at one side.

But once in the elevated ground surrounding the mound proper, was copper met with, and this was so greatly corroded that it was hardly more than a paste-like substance.

Upon several occasions in the mound, copper was found in a like condition.

About 8 feet from the surface of the mound, near one of the streaks of sand dyed with hematite, to which reference has been made, was a flat mass of bitumen, about 6 inches by 8 inches and 1.25 to 2 inches in thickness. Imbedded in this was an oblong bit of sheet-copper, about 1 inch in length by .5 of an inch in breadth.

During the excavation of the mound proper there were found, always with burials, three pairs of ear-plugs of sheet-copper.

One pair has the upper and the lower discs of a similar pattern, consisting of open spaces made with considerable regularity (Fig. 54). There is a circular concavity at the center of each disc. Careful measurements show that while the four discs closely resemble each other, the openings do not exactly coincide in size or in shape, thus precluding all chance of their having been made with a die or stamp. These discs, each about 3.5 inches in diameter, were wrapped in bark. With one set of discs was a vertebra of a fish, which probably had been used to hold the pair

together. The second vertebra was not found, but may have been lost in the excavation.

The interesting design of these discs was shown to Mr. Charles C. Willoughby, of the Peabody Museum, Cambridge, Mass., who writes: "Regarding the enclosed

FIG. 54.—One of four copper discs, forming a pair of ear-plugs. Mound near Crystal river. (Full size.)

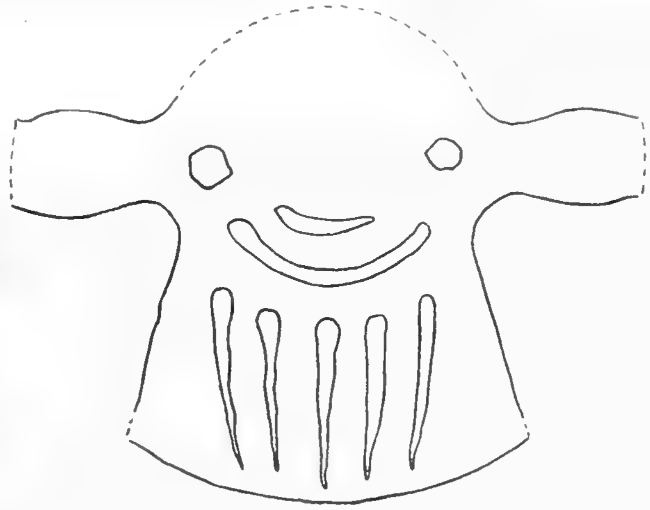


FIG. 55.—Part of copper disc showing animal head, with bear-symbol beneath. (Full size.)

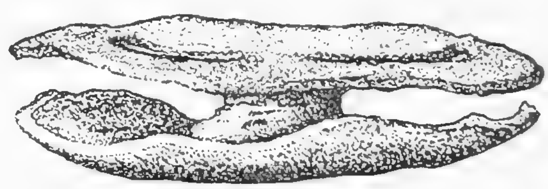


FIG. 57.—Silver-coated ear-plug of copper. Side view. Mound near Crystal river. (Full size.)

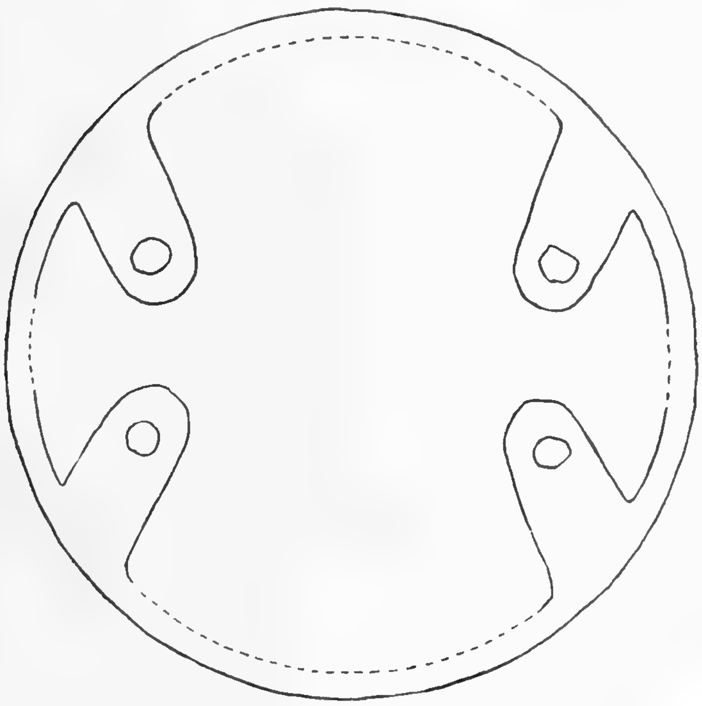


FIG. 56.—Copper disc with animal symbols removed, leaving the cosmic sign. (Full size.)

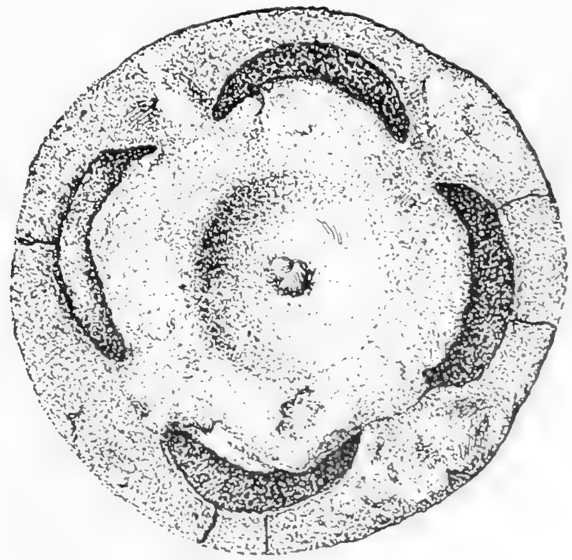


FIG. 58.—The same. Top view. (Full size.)

photograph of the copper disc from Crystal river. This seems to belong to the same type of symbolic forms as many of the sheet-copper objects from the Hopewell and Turner mounds,[1] although the mechanical execution of your ornament is inferior to similar objects from these groups.

"This may well be symbolic of an animal god, probably the bear, combined with the cosmic sign. The animal's head is drawn double, and the design appears the same when reversed. One pair of ears, two eyes and one head answer for both animals, but there are separate mouths, nostrils and necks. The five nearly parallel perforations upon the neck, also duplicated upon the opposite side, doubtless represent the claws of the bear. This symbol occurs several times in modified form in objects of bone and copper from the Hopewell group, and is still used as a bear sign by modern Indians. It seems to me that this mark may be the distinguishing mark of the animal represented.

"The outer circle and four perforated arms doubtless form a cosmic symbol representing the horizon and four directions. The central perforation may also represent the central circle usually present, especially as it seems to have no connection with the head of the animal. The arms representing the four quarters are pushed out of their normal position to make room for the central head."

In Figs. 55, 56 are given, from Mr. Willoughby's designs, part of the copper disc, showing the animal head with the bear symbol beneath, and the copper disc with the animal symbols removed, leaving the cosmic sign.

Another pair of ear-plugs, side and top views of which are shown in Figs. 57, 58, where two missing parts are represented in broken lines, had for decoration on

Fig. 59.—Silver-coated ear-plug of copper. Upper and lower parts. Mound near Crystal river. (Full size.)

top, a thin coating of sheet-silver,[2] hammered on. There is a concave circle in the center and four crescent-shaped open spaces.

The third pair of ear-plugs, wrapped in bark or vegetable fiber and in a woven

[1] For farther information on this interesting subject we would call the reader's attention to "Symbolism in Ancient American Art," by F. W. Putnam and C. C. Willoughby, "Proceedings of the American Association for the Advancement of Science." Vol. XLIV, 1896.

[2] Sheet-gold, sheet-silver, sheet iron (meteoric) have been found in various mounds in Ohio, in which no objects distinctly of European provenance have been met with.

fabric, has circular, concave spaces in the center of the upper and lower portions. The whole outer surface of the upper halves is coated with thin sheet-silver, which, loose in places, has turned up and over. The upper and lower discs were separated by a mass of vegetable fiber through which ran a cord. This cord, passing through a perforation in the middle of the central concavity, on the outside of each upper part is knotted around a pearl which is pierced. The upper and the lower part of one of these ear-plugs is shown in Fig. 59.

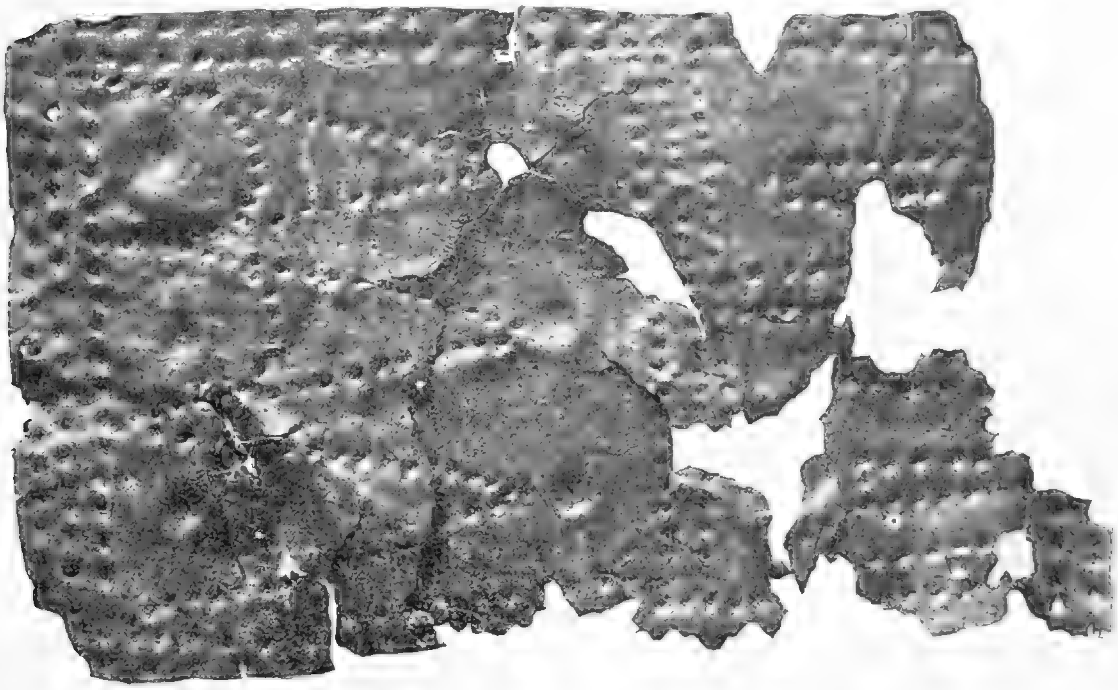


Fig. 60.—Ornament of sheet-copper. Mound near Crystal river. (Three-quarters size.)

Fig. 61.—Ornament of sheet-copper. Mound near Crystal river. (Full size.)

Badly broken when found, was an oblong ornament of sheet-copper (Fig. 60), rather rudely decorated with punctate markings and showing a cruder form of aboriginal effort in repoussé decoration, though in direct line with more ambitious work.

An ornament of fluted sheet-copper, badly broken, came from this mound (Fig. 61). This pattern was a popular one among the aborigines. We have met with it at least twice before, once at Apalachicola and once in the fine mound on Murphy Island, Fla.

Two tubular beads of over-lapping sheet-copper were found in caved sand.

A portion of a second ornament of fluted sheet-copper from this mound was submitted to Prof. Harry F. Keller, Ph.D., who reported on it as follows:

"As to the sheet-copper from the Crystal river mound, it is certainly made from the native metal; a very searching qualitative analysis of the cleaned specimen gave only silver and iron as metallic impurities, and demonstrated the entire absence of lead, arsenic, antimony and zinc."

Here we have native copper such as was used by the aborigines, previous to the coming of the Europeans, which copper was not obtainable in Europe in quantities sufficient for commercial purposes and which is most distinctly different from the copper brought to this country by Europeans, the European copper being the product of arsenical, sulphide ores, and teeming with impurities.

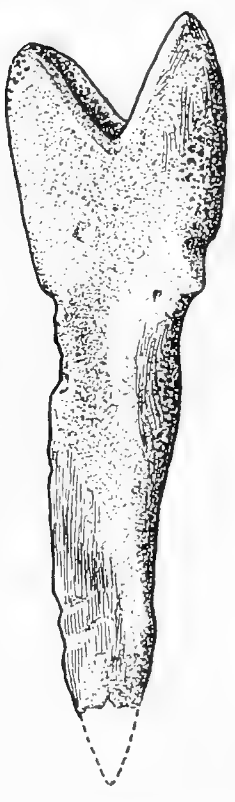


FIG. 62.—Implement of bone. Mound near Crystal river. (Full size.)

Three pointed implements made from cannon-bones of deer, and three shark's teeth of the present geological period, lay with three arrowheads or knives. Such teeth were found by Mr. Cushing at Marco, in the Ten Thousand Islands, Fla., and were shown by him to have been used for the carving of wood.

In one deposit were a number of pointed implements of bone, fragments of other bone implements of various kinds, and a fish-hook of bone, from which the pointed end, broken by the blow of a spade, was lost. With these was an object of bone, perhaps used in basketry (Fig. 62).

Half of a tooth of a fossil shark was met with in the mound.

As to note the exact association of all objects from this mound would unduly occupy our space, a few groups of artifacts, only, will be given as they were found.

With a burial were: one canine tooth of a large carnivore; two "celts" of polished rock; two sheets of mica; three lance-heads of chert; two sandstone pebble-hammers; four shell gouges; four shell "celts;" parts of other "celts" of shell; two sandstone hones; several bits of clayey material.

Together were: two pendants of shell; two pendants of igneous rock; a knuckle-bone of a deer.

Three knuckle-bones of the deer lay with two shell pendants.

With the skeleton of a child were: two pendants of rock; one pendant of shell; a knuckle-bone of a deer.

In one deposit were: half of a bar-amulet of slate; two smooth, flat fragments, one of banded slate, one seemingly of fine-grained sandstone; one pendant of sedimentary rock; one of igneous rock; one of quartz; a beautifully made one of quartz, somewhat worn.

Again we would call the attention of the reader, before ending the account of this interesting investigation, to the fact that nothing showing white provenance was met with during the work and that the entire area gone over by us was absolutely virgin.

Mound near Crystal River Settlement, Citrus County.

The settlement is at the head of Crystal river.

About 1.5 miles in a NNW. direction from the town, on property of Mr. Herman Miller, of Crystal River, in pine woods bordering a hammock, was a sand mound 4 feet 9 inches high and 70 feet across the circular base.

Thorough trenching showed this mound to belong to the domiciliary class.

Mound near the Chassahowitzka River, Citrus County.

The river has its source at a large spring, or boil, about eight miles from the Gulf.

The mound, in pine woods, about one-half mile in a E. by S. direction from the landing at the river's head, was in full view from the road. Though but comparatively little dug into before our visit, seemingly, it had been much trampled by cattle, and bits of human bone and fragments of earthenware were scattered here and there over the entire surface. It was evident that the diameter of the mound, 75 feet at the time of our visit, had been extended at the expense of the height, which was 4 feet.

Fifteen trenches were started inward from the margin and continued until human remains were encountered, when all trenches were joined and the remaining part of the mound, which had a diameter of from 50 to 54 feet, probably about the original diameter, was demolished.

Eighteen burials, all very badly decayed, including the lone skull, were met with. The bunched burial, also, was represented, sometimes without a skull, sometimes with one, and once with two.

With one burial were bits of pottery and fragments of chert. With another was an imperforate pot of inferior ware, bearing a small check-stamp. Certain decaying fragments of bone had with them bits of different vessels. The following vessels were in the mound, not as a general deposit but here and there, singly, perhaps interred with burials since decayed; a small, undecorated, imperforate vessel modelled after a gourd; an undecorated bowl with a basal perforation, having a small depression below the rim at opposite sides; a small vessel without decoration, a flattened sphere in shape, having the usual mortuary mutilation; an undecorated vessel badly broken.

A handle of a vessel, representing the head of a predatory bird (Fig. 63), was

found unassociated with other ware. In the beak is a circular hole which would allow the use of the head as a pendent ornament. We got, on the Island of Marco, one of the northern-most of the Ten Thousand Islands (see outline map) a bird-head handle of a vessel, with a groove around the neck, showing the use of the head as a pendant.

Sherds in the mound were numerous but did not lie in deposits. The great majority are of ordinary ware and undecorated. Some, however, are of excellent material. Red pigment had been used in several instances and punctate markings and the check-stamp are represented. The complicated stamp was not met with.

There were also in the mound, unassociated: a small hatchet, seemingly of igneous rock; a triangular weapon or tool, of chert; a bit of fossil wood; a number of flakes and chippings, of chert; a pendant of volcanic rock (Fig. 64).

Mound near Indian Bend, Hernando County.

This name is given to a bight in the swamp bordering the Gulf, around which grow pine trees, and oaks in places. The mound at Indian Bend is about two miles in a straight line almost due south from the landing at the head of Chassahowitzka river. It had been dug into in a limited way before our visit and seemed, in addition, to have been greatly trampled by cattle. Its height was 4 feet. It was 48 feet across its circular base. Fifteen trenches were dug in toward the center until, at the union of these trenches, a portion from 32 feet to 34 feet in diameter remained. This part was entirely demolished.

Burials, eight in number, in the last stage of decay, were: two lone skulls; four small bunches, each with a skull; one bunch without a skull; and, centrally, a skeleton flexed on the right side with a few shell beads at the wrist.

Fig. 63.—Handle of vessel. Mound near the Chassahowitzka river. (Full size.)

Fig. 64.—Pendant of stone. Mound near the Chassahowitzka river. (Full size.)

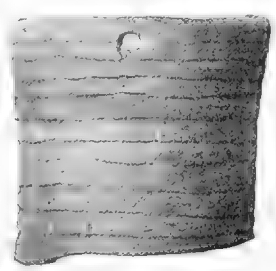


Fig. 65.—Sherd. Mound near Indian Bend. (Half size.)

Exceptionally few sherds were met with in this mound. Most were undecorated; some had the check-stamp; one had encircling, parallel lines incised (Fig. 65) which gave the ware the appearance of the coil method of manufacture.

No whole vessels were found, but a portion of one, undecorated, had a basal perforation carefully rounded after the fracture.

Here and there in the mound, unassociated, were several flakes and fragments, of chert, an arrowhead or knife, and a lance-head, of the same material.

Running through the mound for a number of feet, was a deposit of sand dyed red with hematite.

Mound near Bayport, Hernando County.

Bayport is at the mouth of the Wekiwoochee river.

The mound, owner unknown, lay in scrub and pine, about one mile in a northerly direction from the town. One small hole was the only previous digging noticed by us, but, at the center, there seemed to be a certain flattening as though a building had been there, and that such had been the case was the belief in Bayport. As the mound was on a natural elevation and no base-line was at any time apparent, we found it impossible to decide as to height. Judging from appearances, the altitude was 3 feet 7 inches, but as nothing showing human origin is believed to have been found during the digging, at a depth greater than 2 feet, the mound may have been lower than it appeared. The diameters of base, as taken by us, were 84 feet N. and S., and 76 feet E. and W., but here again, our judgment may have been at fault. At all events, one burial and sherds at various points, were found soon after digging began. The area as given above was completely dug through.

Burials were found marginally in various parts of the mound and continued to be met with, occasionally, until the more central parts of the mound were reached, when they were fairly numerous. All were so badly decayed that no bones were saved. Such crania as were sufficiently preserved to allow determination showed no sign of flattening. In all but three cases, the form of burial was of the ordinary bunched variety. Of these bunches, thirty-four had one skull; four bunches had two skulls; four bunches had three skulls; one had four skulls; one had six skulls; one bunch had seven skulls. Three bunches had no crania with them.

Three other bunches had with them small deposits of fragments of calcined human bones. Twice the deposits were mingled with some unburnt bones belonging to the bunched burials. In these cases the calcined fragments were so few in number that a fractional part of the skeleton only was represented. The third deposit, near a burial, but not in contact, was somewhat larger, perhaps amounting to several quarts.

With various burials were: three conch-shells and bits of pottery; certain fragments of earthenware; two earthenware vessels in fragments; a bit of chert; six conch-shells; two implements made from marine univalves (*Fulgur perversum* and *Fasciolaria*) by removing part of the body-whorl; sand dyed with hematite; sand less deeply tinged with the red oxide; two small shells much decayed; one "celt."

Over one burial was a large fragment of what must have been a bowl of great size, of inferior ware, roughly decorated. On the fragment was one large loop-shaped handle.

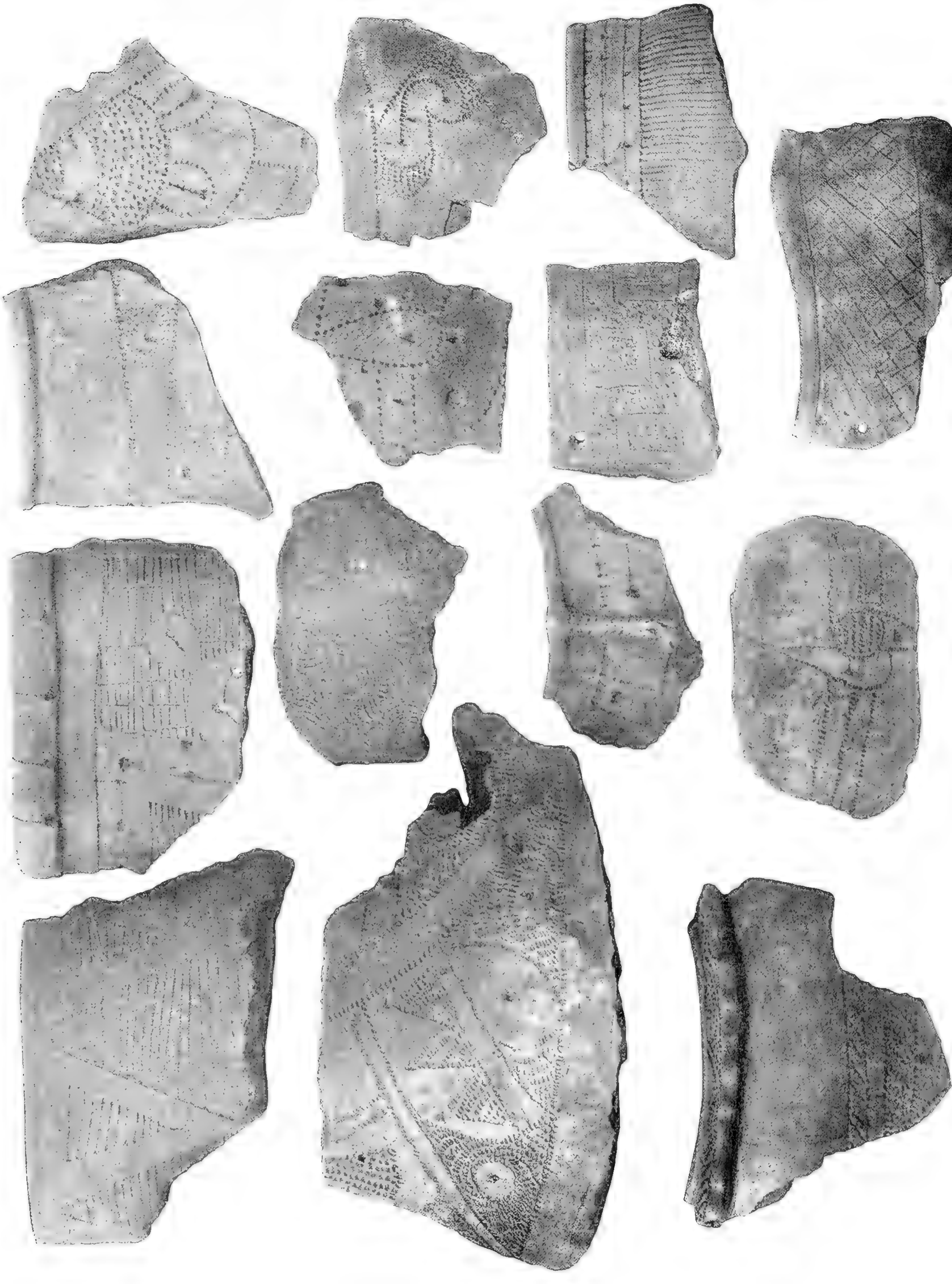


Fig. 66.—Selection of sherds. Mound near Bayport. (Half size.)

There were also in the mound: marine shells, more or less broken (*Fulgur*, *Fasciolaria*) with the lower outer portions removed, and sharpened at the lower end of the columella so that, when the upper part of the shell was held in the hand, they could be used to bore or to pierce with; chips, flakes and fragments, of chert; several arrowheads or knives, also of chert, some of which were broken, some only rudely blocked out; four "celts," one showing marks of service in a handle; two very diminutive "celts;" a few fragments of what had been an ornament of sheet-copper.

At the very margin of the mound, in various directions, were small deposits of sherds made up of parts of different vessels, while single sherds and smaller deposits were met with throughout the mound. The ware, as shown by these fragments, is, in most cases, inferior, though some is of excellent quality. Much is undecorated. One sherd, seemingly, is cord-marked, though this decoration is hard to determine. A few bear traces of crimson pigment; many have the check-stamp of various sizes; several have the complicated stamp, including the design of concentric circles, so much in vogue in this district. One has a complicated pattern shown by us in Fig. 66, Part II, of our "Certain Aboriginal Remains of the Northwest Florida Coast." Some sherds from this investigation bear incised decoration alone; some, punctate decoration, in addition, but the specialty of the builders of the mound was the punctate impression in various combinations. A selection of sherds from the mound is shown in Fig. 66 and others are given in Figs. 67, 68, 69, 70.

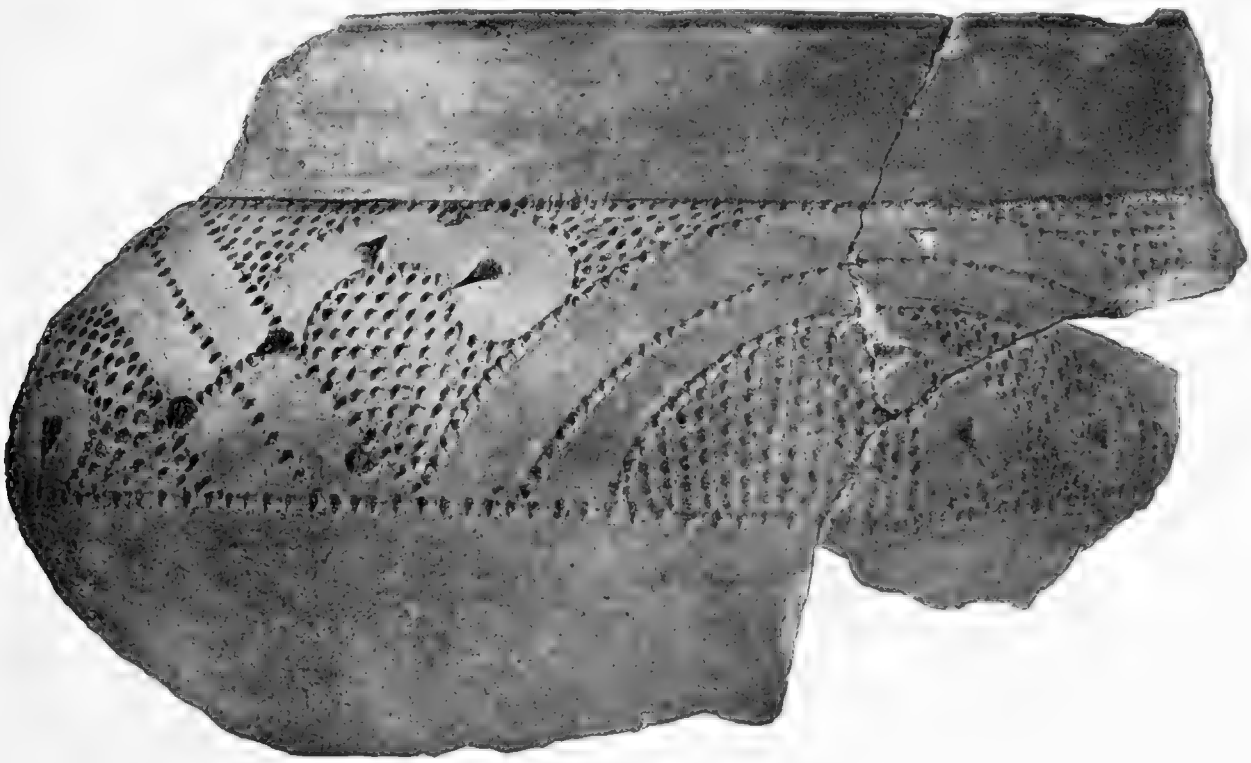


FIG. 67.—Sherd. Mound near Bayport. (Three-fourths size.)

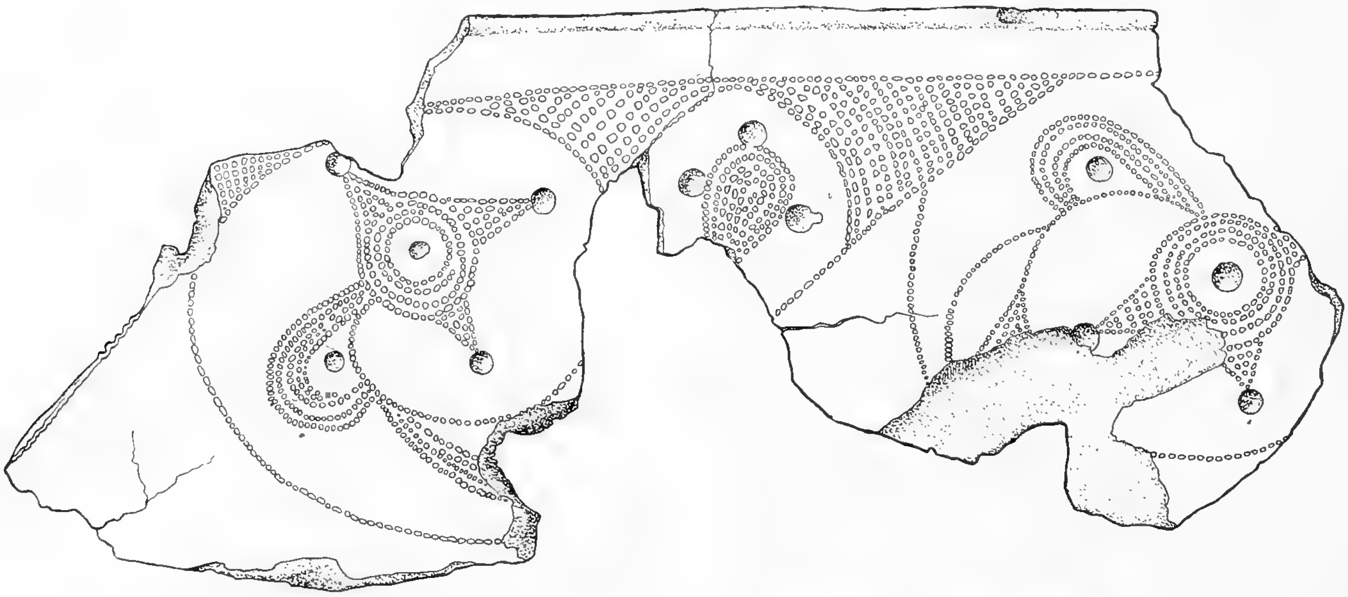


FIG. 68.—Sherd. Mound near Bayport. (Half size.)

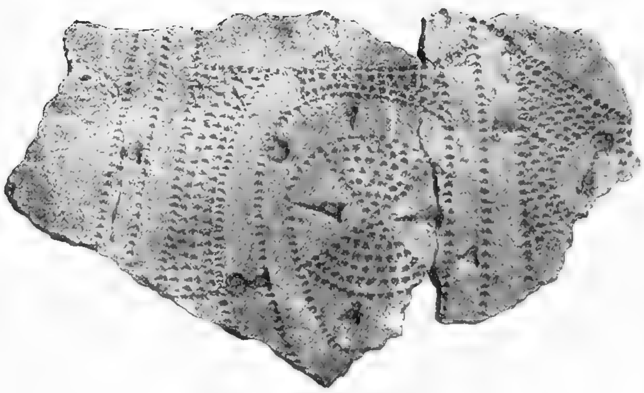


FIG. 69.—Sherd. Mound near Bayport. (Half size.)

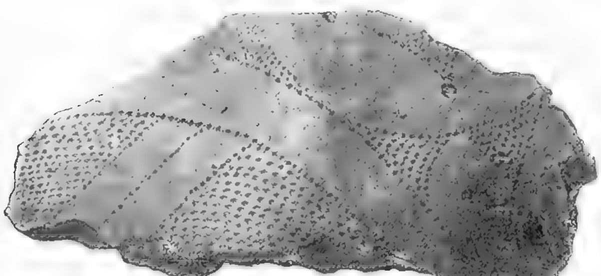


FIG. 70.—Sherd. Mound near Bayport. (Half size.)

FIG. 71.—Part of vessel of earthenware. Mound near Bayport. (About four-fifths size.)

Part of a vessel, found in several bits, shows an interesting decoration and indicates a graceful form though, unfortunately, the entire base and most of the neck, are wanting (Fig. 71). The sand for some distance around these fragments was carefully sifted without discovery of farther trace of the vessel and it became evident that the pieces had been interred as fragments only.

In view of the evidence furnished by some of the sherds that the makers of the mound posessed ware superior as to quality, form and decoration, the entire vessels met with by us were doubly disappointing.

Soon after the digging began, in the eastern margin of the mound, at a distance from human remains, evidently placed in the mound for the use of the dead in common, as were all deposits of vessels in this mound, with one exception, was Vessel No. 1 (Fig. 72), of most inferior ware, with six projecting knobs, undoubtedly

FIG. 72.—Vessel No. 1. Mound near Bayport. (About two-thirds size.)

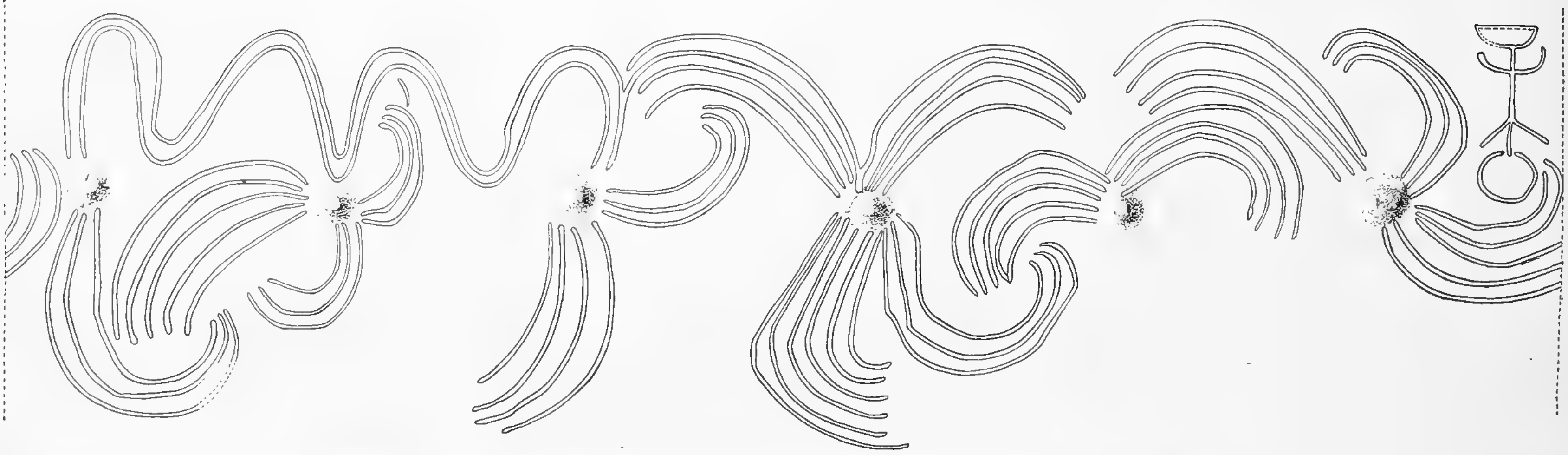


FIG. 73.—Vessel No. 1. Decoration. Mound near Bayport. (One-third size.)

FIG. 74.—Vessel No. 2. Mound near Bayport. (Full size.)

highly conventionalized head, tail and legs of a life-form. The decoration, traced on the clay before firing, is rude (diagram, Fig. 73). In the base is a carefully rounded perforation made after baking, as was the case with all vessels in this mound, except such as are described to the contrary.

With this vessel, in fragments which have since been put together, was Vessel No. 2, of excellent ware (Fig. 74), with incised and punctate decoration shown diagrammatically in Fig. 75. There are duck-head handles.

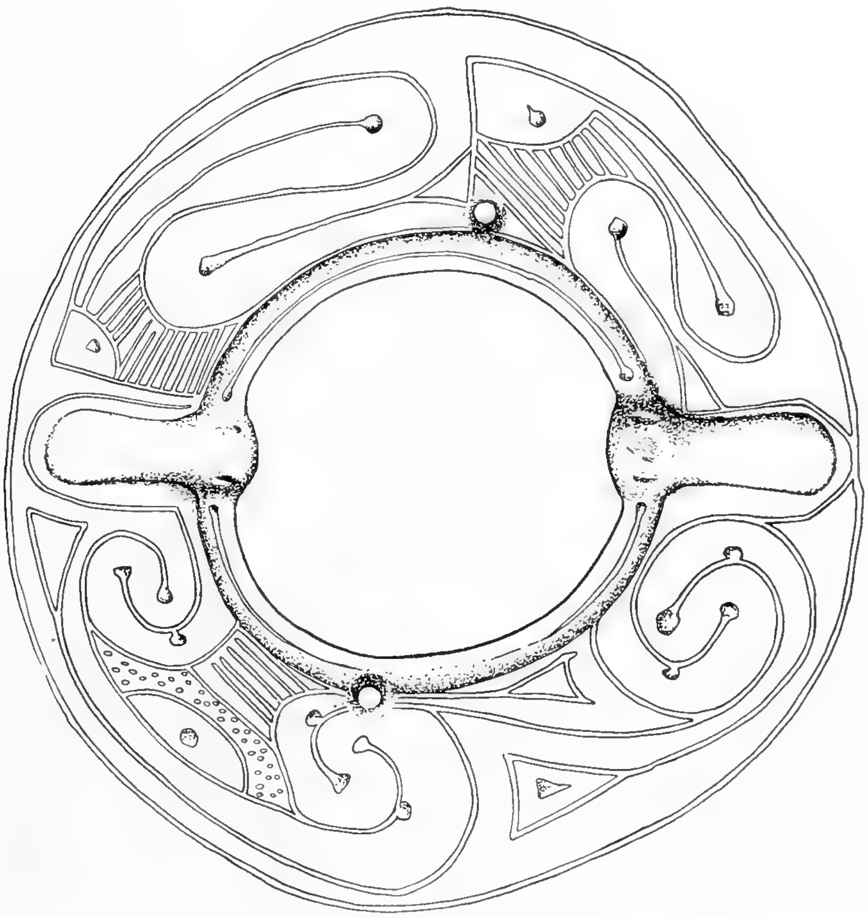


FIG. 75.—Vessel No. 2. Decoration. Mound near Bayport. (Half size.)

Somewhat farther in, still in the eastern part of the mound, unfortunately shattered by the blow of a spade, was a vessel, an inverted, truncated cone in shape, with a check-stamp decoration. This vessel was too badly broken to determine as to basal perforation.

A little later, in the same direction, an undecorated, globular vessel was met with.

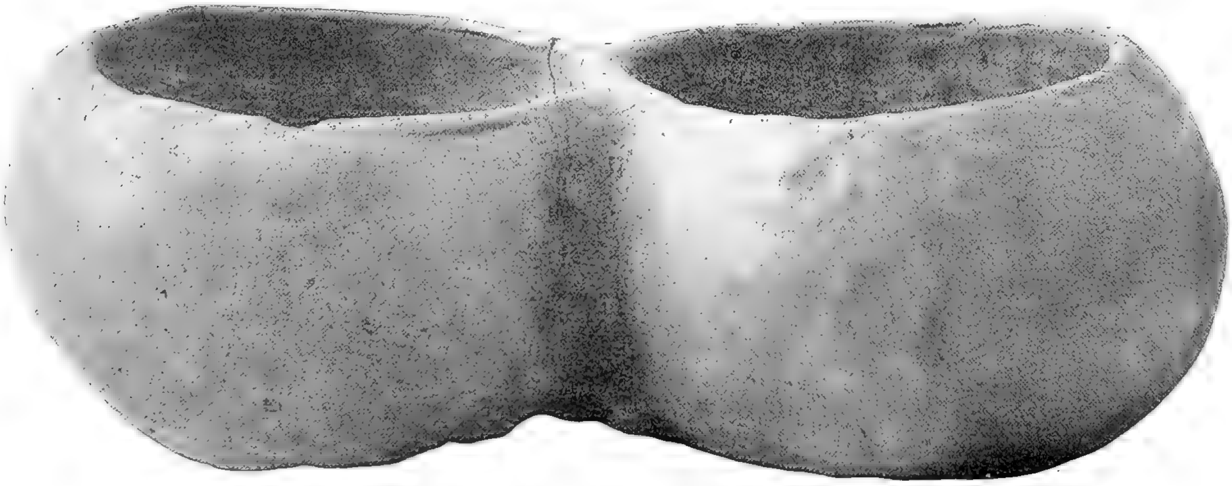


FIG. 76.—Vessel No. 5. Mound near Bayport. (About two-thirds size.)

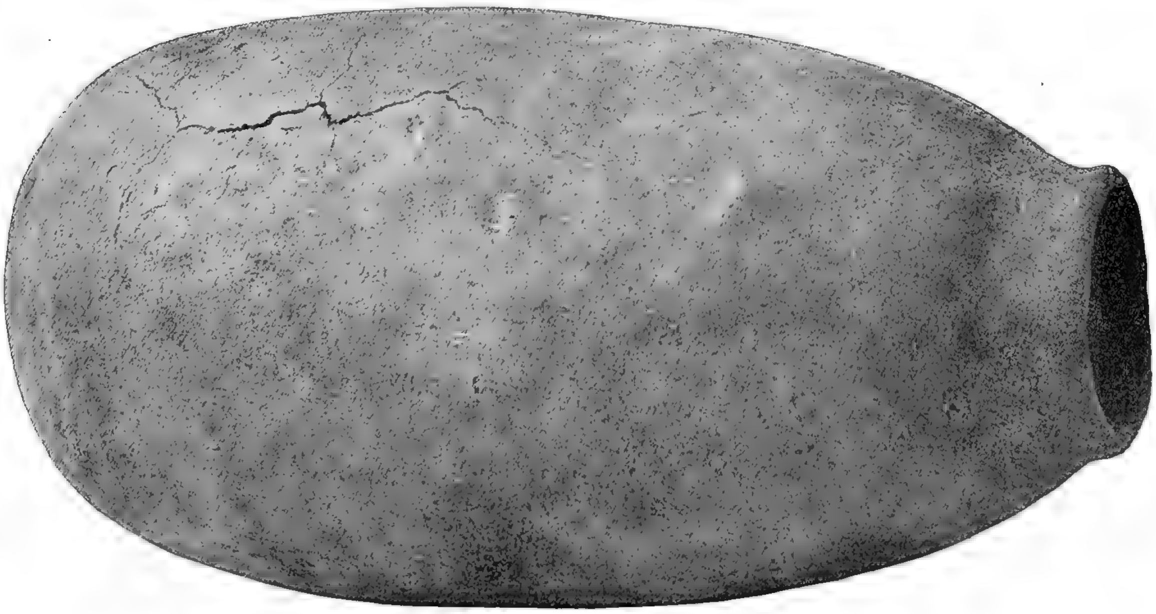


FIG. 77.—Vessel No. 6. Mound near Bayport. (About three-fifths size.)

From the southern part of the mound came Vessel No. 5 (Fig. 76) which formerly had had double, circular compartments. The greater part of one compartment has been restored.

Still in the marginal part of the mound, the northwestern portion, but farther in than the vessels already described, together, were nine vessels, Nos. 6 to 14, inclusive, all of most inferior ware, some upright, some lying on the side, some inverted.

Vessel No. 6.—A jar of about 3 quarts' capacity (Fig. 77), undecorated, has a curious projecting base in which is a perforation made before baking. Three other vessels of this type came from this mound. Almost, there would seem to be cause to doubt whether these curious, open, projecting bases entitle the vessels to which

they belong to be classed among the ready-made mortuary variety. Possibly the vessels may have been used as sieves or strainers with a fabric inserted on the bottom.

Vessel No. 7.—A globular vessel of about 6 quarts' capacity, undecorated, with a small vertical rim, a part of which was missing when the vessel was found.

Vessel No. 8.—A quadrilateral vessel with rounded base, shown in Fig. 78.

Vessel No. 9.—This vessel, similar to Vessel No. 6, was sent to the Peabody Museum, Cambridge, Mass.

Vessel No. 10.—A large bowl in many fragments, having the upper part faintly decorated with a complicated stamp composed of concentric circles.

Vessel No. 11.—A pot of about 3 gallons' capacity, having on the upper part of the body a faint check-stamp.

FIG. 78.—Vessel No. 8. Mound near Bayport. (About four-fifths size.)

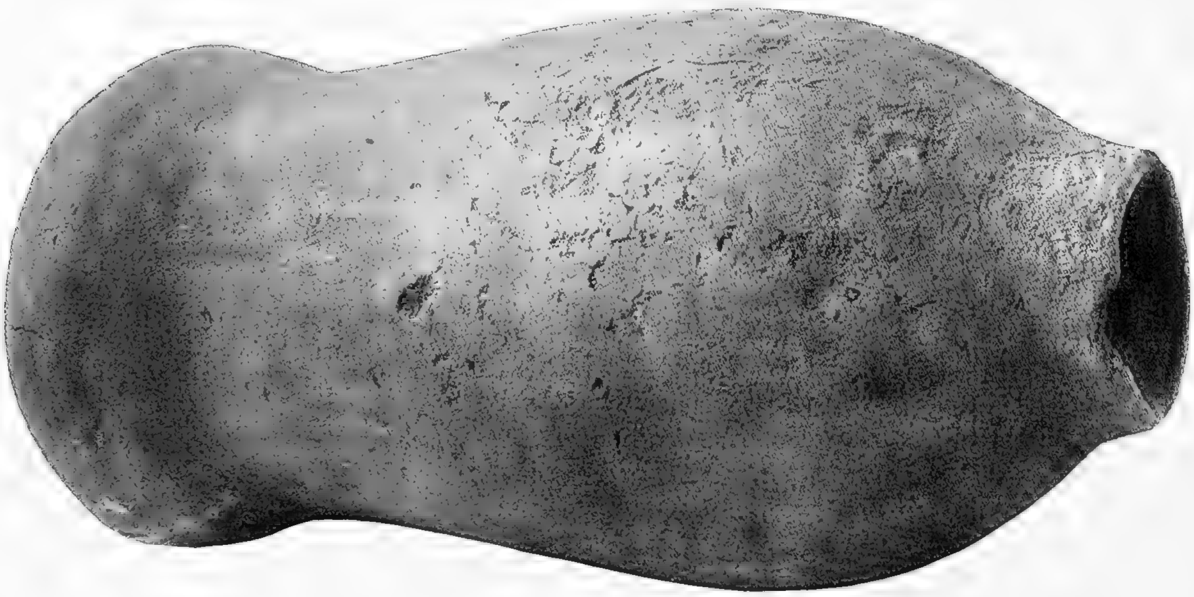


Fig. 79.—Vessel No. 12. Mound near Bayport. (About three-fifths size.)

Vessel No. 12.—A jar of the same type as Vessels Nos. 6 and 9, with protruding base and ready-made perforation, shown in Fig. 79, but differing slightly in outline. The reader will bear in mind that properly to show the base, the aperture of the vessel has been turned away.

Vessel No. 13.—Badly broken, similar to Vessels Nos. 6 and 9.

Vessel No. 14.—A badly broken vessel having a check-stamp decoration.

Vessel No 15.—Alone in the sand was a small vessel, oblate spheroidal, undecorated, with narrow, upright rim. The carefully-made, circular hole in the base, looking as though, after a small piece had been broken out, the margin of the break had been rounded by a cutting implement, was not present in this case, the entire bottom having been knocked out.

In the body of the mound, NE. part, with a burial, were two large, undecorated vessels in fragments (Numbers 16 and 17).

Mound near Indian Creek, Hernando County.

Indian creek enters the Gulf about five miles south of Bayport.

Surrounded by marsh, about 400 yards ENE. from the mouth of the creek, on property of Mr. Richard A. Ellis, of Aripeka, is a small patch of solid ground on which grow a few palmettoes and pines. In the center, was an artificial elevation about 2.5 feet high and 42 feet across the base. Previous digging had been confined to a small, central hole.

The mound was entirely demolished by us except portions around several trees. The material was tough, clayey sand.

Near the center were two bunched burials, each with a skull, and a skeleton closely flexed on the right side.

No artifacts of any sort were met with.

Mound near the Wekiwachee River, Pasco County.[1]

The mound, in pine woods, in full view from the Tampa road, was about two miles in a SSE. direction from the mouth of the Wekiwachee river, also called Hammock creek.

At one side of the mound was a depression whence the sand had been taken, and about 100 yards distant was a fresh-water pond where the aborigines found a supply of water.

The mound had been dug into, centrally, to a certain extent before we came and bits of bone and fragments of pottery were scattered on the surface. The area of the base, which seemed to have been extended somewhat by the trampling of cattle, was 86 feet by 64 feet. The height of the mound was a trifle over 4 feet. What seemed to be the mound proper, was entirely dug down by us, except small parts around certain trees. Sand, apparently washed and trampled from above, presumably not belonging to the mound, though in appearance a part of it, was excluded from the investigation.

Burials were met with from the very start and continued in until a deposit of bones, spread in a layer, was encountered, which occupied all the central part of the mound, at a depth of about two feet from the surface. In this layer, with other bones, were seventy-six skulls, and, doubtless, the digging preceding our own removed certain others.

The sole, and rather incommensurate, votive offering with this great deposit of bones was a vessel of earthenware, of about one quart capacity, a flattened sphere in shape, having traces of red paint on the exterior and a small mortuary perforation in the base.

There were also in the mound:

Bunched burials each having one skull, ...	40
Bunched burials with two skulls each, ...	11
Bunched burials with three skulls each, ...	2
Bunched burials with four skulls each, ...	2
Skeletons closely flexed on the right side, ...	5
Skeletons closely flexed on the left side, ...	3
Bunched burial with no skull, ...	1

Four additional burials, each with a single skull, fell with caved sand.

There was also a small pocket of calcined fragments of human bone, perhaps about one quart in all, present in the mound.

The condition of the bones was such that no skull was saved. No cranial flattening was noticed on any of the fragments.

The aborigines who built this mound were not liberal in offerings to the departed, as was indicated by the comparative lack of artifacts with the great deposit. The skeleton of a child had three shell drinking-cups and two unwrought

[1] This river must not be confounded with the Wekiwoochee river, some eight miles away.

conchs (*Fulgur perversum*), while two shell-cups lay each with another burial. With one burial was sand dyed with hematite.

With a bunched burial was a gracefully made "celt;" with another, two equally as well-made.

Not immediately associated with burials were: one hammer-stone; two lance-heads, of chert, each about 3.5 inches in length; a well-made spear-head of chert, about 5 inches long and about 2 inches in maximum diameter. A grooved pendant, rather roughly made from a pebble, lay alone in the sand.

In the southern margin of the mound was a small deposit of sherds and, here and there in the mound, fragments were met with singly, bearing red pigment, the

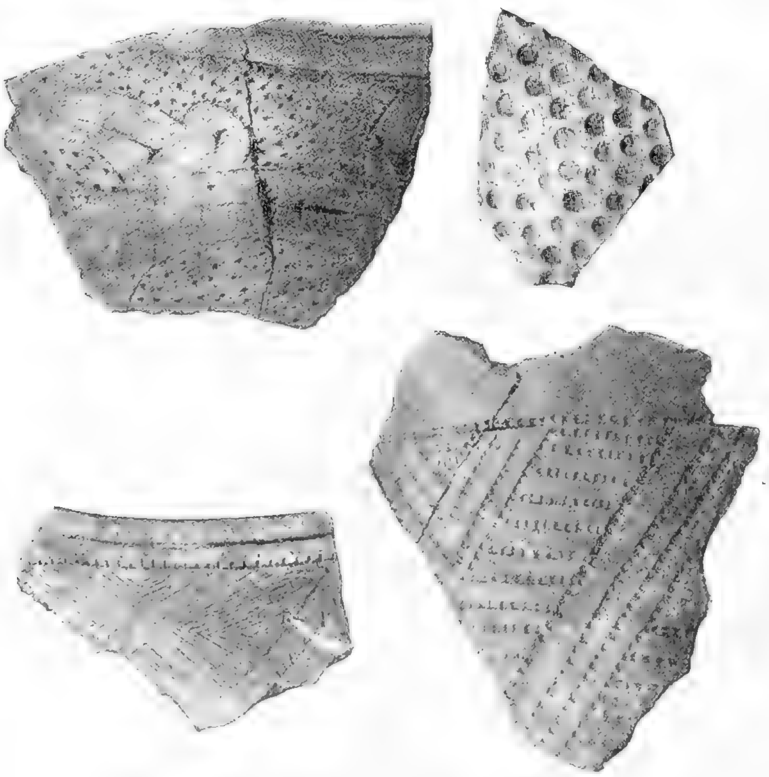


FIG. 80.—Selection of sherds. Mound near the Wekiwachee river. (Half size.)

check-stamp, punctate markings. There were several fragments with a complicated stamp in which the concentric circle figured. A selection of sherds from this mound is shown in Fig. 80.

Part of a vessel was met with showing a basal perforation made before the firing of the clay.

MOUND NEAR THE PITHLOCHASCOOTIE RIVER, PASCO COUNTY.

This river, variously spelled on maps and charts, is commonly spoken of as the "Kootie."

About three-quarters of a mile from the mouth of the river, on the S. side,

visible from the water, on property of Mr. E. B. Liles, of Ehren, Fla., is an oblong mound running almost north and south, 142 feet along the base and 70 feet across it. The summit plateau is 91 feet long and 19 feet in width. The height is 9 feet. The mound, composed of alternate layers of sand and of shell, as is shown by former excavations, is probably domiciliary.

Mr. S. T. Walker, in the *Smithsonian Report* for 1879, page 392, *et seq.*, has described, and given plans of, this domiciliary mound and of the burial mound nearby, a description of which we are about to give.

About 100 yards in an easterly direction from the domiciliary mound is a mound of sand, of irregular outline (see Plan, Fig. 81), also on property of Mr. Liles. The mound, narrowest at its western end, slopes gently upward for 58 feet,

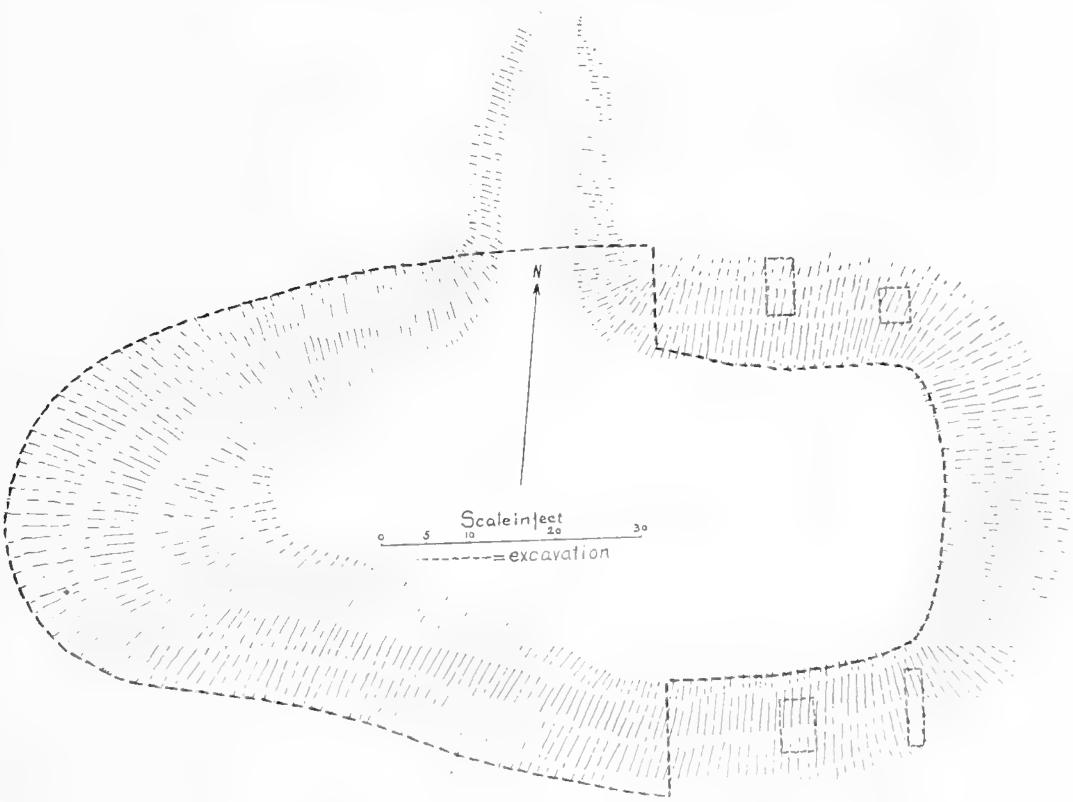


Fig. 81.—Plan. Mound near Pithlochascootie river.

when the maximum height, 4 feet, is reached. There is then a decline of 65 feet to the level ground at the eastern extremity of the mound. Mr. Walker is in error in ascribing to the sand mound a height greater than that of the domiciliary mound, and in his plan of the burial mound has reversed the position of its ends, putting the broader end at the western extremity.

There had been comparatively little previous digging, considering the size of the mound. Mr. Walker's digging, amounting to but little, was plainly traceable.

The western, or narrower part of the mound, which, however, included the highest part, was entirely dug through by us to include 76 feet of the length of the base. The remaining, or eastern portion of the mound, 47 feet in length along the base, was dug through by us with the exception of the outer parts, in which neither burials nor artifacts were found by trenching. The total area of our investigation is shown in broken lines on the plan. The arm, or causeway (see plan) having been dug by Mr. Walker, was not investigated by us.

The mound, of sand, rested upon a foundation of clay on which, here and there, were masses of lime-rock. Whether these masses were put in place by aborigines at the making of the mound, we are unable to say, though it is our opinion they were not, as an excavation made by us at some distance from the mound yielded similar masses of rock.

There were in the mound, locally, along the base, deposits of oyster-shells. These deposits had no direct connection with the burials.

Mr. Walker says, in speaking of this mound: "Excavations systematically conducted revealed human remains in vast quantities in every part of the mound."

Burials were numerous in places but were not present in others. Some of our men dug through undisturbed sand during many hours without coming upon a single bone. Mr. Walker says also, "The mode of burial was interment at full length, with the heads directed toward a common center, the body reclining on its right side; I discovered three of these circles of bodies, each containing from seven to fourteen adult skeletons."

We met with nothing in the mound to indicate this method of burial, and we may say, incidentally, we have not found it in several hundred mounds opened by us in the southern United States.

Human remains were found in the mound at sixty-two places.

The skeletons in the mound lay as follows:

Partly flexed on the right side, ...	5
Partly flexed on the left side, ...	6
Closely flexed on the right side, ...	13
Closely flexed on the left side, ...	7
Full length on back, ...	2

The heads of the skeletons pointed as follows: E., 4; E. by S., 1; ESE., 3. SE., 3; SSE., 3; S., 1; WSW., 3; W., 1; W. by N., 1; WNW., 1; NW., 1; NE., 2; ENE., 5; E. by N., 4.

The upper half of a skeleton, perhaps an aboriginal disturbance, had the cranium directed toward the south.

It was noted as an invariable rule in this mound that the skeletons lay on the base, while the lone skulls, of which there were seven, and the bunched burials, of which eighteen were met with, were considerably higher in the mound.

The bunched burials were as follows:

With no skull present,	1
With one skull,	8
With two skulls,	2
With three skulls,	4
With five skulls,	1
With eight skulls,	2

A number of scattered bones found by us at one point in the mound, was perhaps an aboriginal disturbance.

There were included in our enumeration also one recent disturbance, and one burial details as to which we do not find in our note book.

About two-thirds the length of the mound from the western extremity, well in toward the median line and continuing inward and eastward, not always in close contact but spread, was a deposit of bones with which were fifty-seven skulls. With this great mass, were three small deposits of calcined human bones. All this was scored as one burial and completes the sixty-two burials counted by us.

No skulls were saved from this mound. Judging from large fragments found, cranial compression had not been practised.

With burial No. 1, a recent disturbance, were Vessels Nos. 1, 2 and 3, all of most inferior ware, and in fragments.

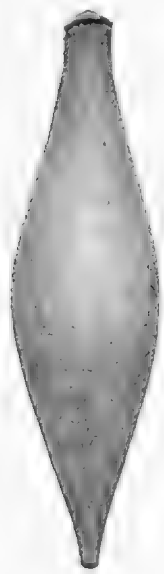


FIG. 82.—Pendant of slate. Mound near the Pithlochascootie river. (Full size.)

A conch-shell lay with a lone skull, and similar shells were with burials or unassociated.

Burial No. 22, a skeleton closely flexed on the left side, had on the pelvic portion a beautiful pendant of slate (Fig. 82).

With a bunched burial was a graceful arrow- or lance-head of chalcedony, while a flake of chert, evidently used as a knife, lay with another bunched burial.

A skeleton closely flexed on the right, Burial No. 32, had with it: one hammer-stone; four small masses of cherty material; part of a lance-head or of a dagger, of chert; five fragmentary objects of shell, chisels, etc.; one tibia and one humerus, belonging to the deer; three deer tibiæ and one humerus, in fragments; one astragalus of a deer; bits of bone mainly belonging to the deer; part of a jaw of a small mammal; fragments of pointed implements of bone; five entire implements wrought from leg-bones of deer, and two, each broken into two parts; three tubes of bone, each about 1.5 inches in length.

Near Burial No. 33, a skeleton closely flexed on the right side, were three piercing implements wrought from cannon-bones of deer, and a number of fragments of bone, probably parts of implements.

In the southern part of the mound, with Burial No. 30, a skeleton flexed on the right side, was an inverted bowl, Vessel No. 4, oval in horizontal section, 13.8

inches by 15 inches in maximum diameter, 8.5 inches high, 6.5 inches by 7.5 inches in diameters of aperture, with in-turned rim and rude, incised decoration shown in Fig. 83. So stout was the ware that it resisted a number of blows of a spade, aimed at neighboring palmetto roots. There is a rounded perforation in the base, made after the completion of the vessel, and another in the side.

FIG. 83.—Vessel No. 4. Mound near Pithlochascootier iver. (About half size.)

On the base of the mound, as was the other, and about 6 feet east of it, inverted, with Burial No. 42, a skeleton closely flexed on the right side, was Vessel No. 5, a bowl of excellent yellow ware, 18 inches in diameter, 7.75 inches high and 13.8 inches across the opening. This vessel (Fig. 84) has red pigment interiorly and red coloring matter within two of each of the four triangles which make up the oblong spaces between the groups of parallel vertical lines of the decoration. With Burial No. 42 was also a small pendant of sedimentary rock, having a conventional bird-form, shown in two positions in Fig. 85, while a well-made pendant of metamorphic rock (Fig. 86) lay with another burial.

A bunched burial had near it an ungrooved quartz crystal, and a rather rude lance-head of chert was with another bunched burial.

With the large deposit were two "celts," a conch-shell, a long pendant made from a columella of a marine univalve, and three pendants of lime-rock, much the worse for age.

Fig. 84.—Vessel No. 5. Mound near the Pithlochascootie river. (About two-fifths size.)

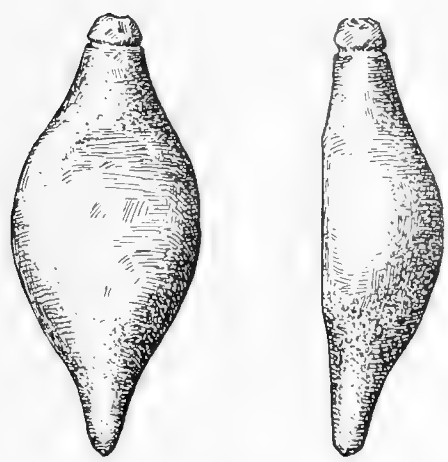


Fig. 85.—Pendant of sedimentary rock. Two positions. Mound near the Pithlochascootie river. (Full size.)

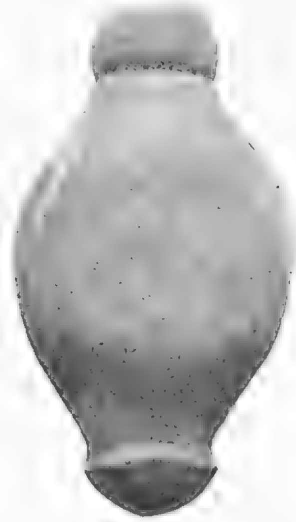


Fig. 86.—Pendant of metamorphic rock. Mound near the Pithlochascootie river. (Full size.)

At places throughout the mound, usually singly, was a considerable number of fragments of chert, also flakes of chert, evidently used as knives, and many cutting

tools of chert, half wrought or very rudely worked, if complete. There were also several implements made from columellæ of marine univalves. Apparently unassociated, were: one "celt" showing much wear where the handle had been; two roughly chipped cutting implements of cherty material, each about 7 inches long and each somewhat broken at the smaller end; one graceful pendant of shell; two stone pendants found separately; seven arrow- and lance-heads, of chert, some barbed and beautifully pointed; one drill of chert; and several small cutting tools of the same material; two arrowheads which, partly broken, had been rounded for use as scrapers; the lower part of a fine lance-head of chert; an implement 5 inches long, of smoothed quartz material.

In this mound were no deposits of sherds other than, possibly, two or three fragments lying together though, here and there, sherds were met with unassociated. Some were undecorated and of inferior ware; others gave evidence that vessels of excellent ware and superior decoration had been possessed by the makers of the

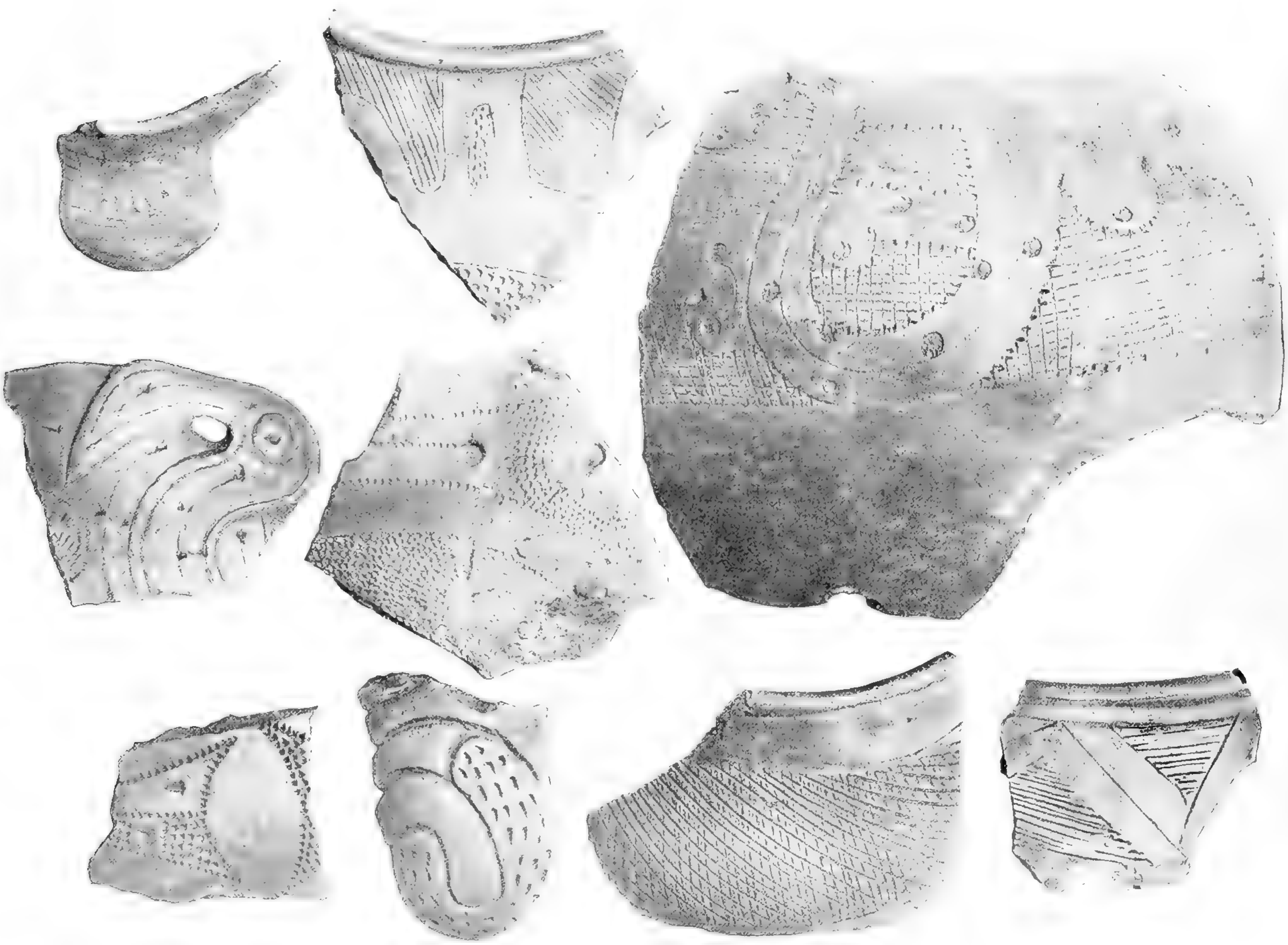


FIG. 87.—Selection of sherds. Mound near the Pithlochascootie river. (Half size.)

mound. Many sherds bore the ever-present check-stamp; the complicated stamp was on one sherd only. Some had a decoration of crimson pigment; others, incised and punctate designs. A selection is shown in Fig. 87. The reader will note in the right hand upper corner a sherd, handsomely decorated, where a portion of the design is carried above the rim. One interesting sherd, of excellent ware, shows the head of a bird with peculiarly shaped bill beneath which is a perforation which may be one of two made for the suspension of the vessel, or a single hole to allow the fragment to be worn as a pendant.

Mound near Tarpon Springs, Hillsboro County.

This mound is referred to, incidentally, as it belonged to those of the district of which we are writing.

The mound is described by Mr. S. T. Walker (*op. cit.*, page 394 *et seq.*) under the heading of the Ormond mound on the Anclote river. Such digging as was done by Mr. Walker, after members of Mr. Ormond's family had tried their hands at it, yielded nothing of importance.

In 1895, what remained of the mound was totally demolished by the late Mr. Frank Hamilton Cushing, who reported[1] the discovery of many burials and also of a pendant of crystal, a pendant of copper and many fragments of earthenware. These fragments will be figured and described in Prof. W. H. Holmes' "The Pottery of the Eastern United States," which will be published as the Twentieth Annual Report of the Bureau of American Ethnology.

Mound on Hog Island, Hillsboro County.

Hog Island lies between part of St. Joseph sound and the Gulf.

The mound, on property of Mr. Henry Scherrer, living nearby, is about one mile in a northerly direction from the southern extremity of the island. It lies on low ground which is entirely surrounded by water at high tide, and seems a curious selection for a place of burial.

The mound, composed of a mixture of sand and of small marine bivalves (*Venus cancellata*), the same genus as our round clam, had been wofully dug into, centrally, and from the sides, previous to our visit, when it was completely demolished by us, with the exception of parts surrounding two trees.

Burials in this mound lay, as a rule, near the base and in graves below the base. Many skeletons, we were told, had been removed by former diggers and many others, remaining, showed great disturbance.

Thirty-three skeletons were met with by us, buried as follows:

Closely flexed on the right side,	21
Closely flexed on the left side,	7
Partly flexed on the right,	1
Closely flexed, face down,	2
Closely flexed on the back,	1
Disturbance by our diggers,	1

[1] "Proceedings of the American Philosophical Society," Vol. XXXV, No. 153, Phila., 1897.

Two of these burials had above them a skull, and a skull with a femur, respectively, aboriginal disturbances.

There was also in the mound a burial, presumably intrusive, as it was but 2 feet below the surface and was in a better condition than the other burials, although they, owing to the infiltration of lime-salts, were in a state of preservation much superior to that usually met with.

Nineteen skulls were saved from this mound, none showing cranial flattening. Three of these, showing marked pathological changes, were sent to the United States Army Medical Museum, Washington, D. C.; four are now in our Academy of Natural Sciences (Catalogue numbers 2206 to 2209, inclusive); nine probably will be added to the collection, later. Three of the nineteen skulls subsequently fell into fragments.

In the count of burials found by us, bones scattered by former diggers are not noted. In addition, we may have passed over certain burials in graves, if any lay beneath trenches put in by former diggers.

This mound, in a negative way, is about the most remarkable one in our experience for, in the parts dug down by us, not a single fragment of pottery was met with, nor was any artifact of any sort discovered, with the exception of part of a small implement, probably of coralline lime-stone. Neither was there in the mound, according to the reports of our diggers, over whom was close supervision, in addition, any unworked pebble, conch-shell, or fragment of chert. In a word, practically nothing imperishable had been placed with the dead, if we except powdered hematite, in several instances.

Mound near Clearwater, Hillsboro County.

The mound, in sight from St. Joseph sound, and but a few feet from the N. end of the bridge across Steven's creek, about 2 miles in a N. direction from Clearwater, is 75 feet across the base and 5 feet in height. Fifteen excavations in various parts of the mound strongly suggested a domiciliary character for the mound.

Mound near John's Pass, Hillsboro County.

This mound, described by Mr. S. T. Walker (*op. cit.*, page 401 *et seq.*) lay near the SE. end of a nameless key which, extending east and west, lies just inside of John's Pass. The mound, on a low ridge, a portion of which had been dug into to make it, had sustained considerable investigation before our visit, when it was completely demolished. The diameter of the circular base was about 35 feet; the height, 2 feet 4 inches. The mound was composed of sand and of broken shells, not shell-heap material, but fragments of shells, washed up by the sea.

Although, as we have said, there had been much previous digging, a large percentage of the area of the mound was intact and afforded a good idea of what the mound and its contents had been. Burials extended more than one foot below the base, into broken shell material of the kind we have described, mixed with a little sand. In addition to disturbances by comparatively recent diggers, we noted six

skeletons, three flexed on the right side, three on the left side. Also, there was on the S. side of the mound, a great number of bones, including a large number of crania, spread along the lower part of the mound. So thickly were these bones placed, at times, that eight or ten skulls were in sight within a comparatively small space. Unfortunately, though the admixture of shell in the mound tended to preserve the bones, close packing of long-bones against crania had crushed the facial bones of most of the skulls. Twelve crania, none showing flattening, were saved from this mound, six of which are now in the Academy of Natural Sciences (Catalogue Nos. 2210 to 2215, inclusive), and six, we trust, will be added later.

With certain burials, was sand dyed with hematite but no artifacts lay with the dead, though throughout the mound, were ten or a dozen shell drinking-cups (*Fulgur perversum*), some neatly made. Curiously enough, none had the usual basal perforation.

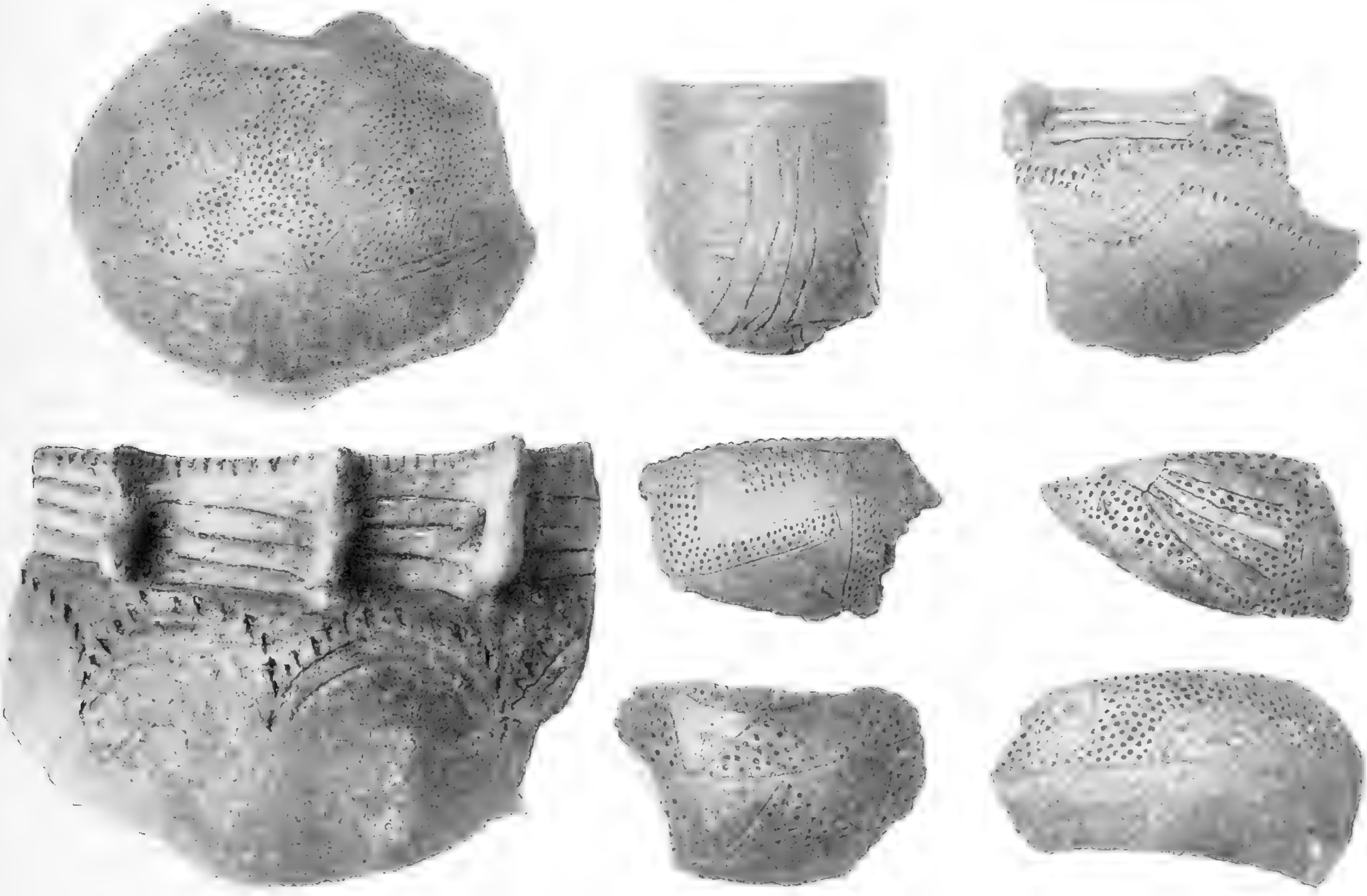


FIG. 88.—Selection of sherds. Mound near John's Pass. (Half size.)

Mr. Walker says of this mound, "The surface about the base was thickly strewn with fragments of pottery; in fact it seemed that the whole foundation of the mound was covered with broken pottery previously to the interment of any of the bodies."

There were a number of sherds in the mound, here and there, at various depths, but we saw nothing to bear out Mr. Walker's statement on the subject. These sherds, the only artifacts in the mound, except the drinking-cups, were of inferior ware and rudely decorated, when at all. The check-stamp was present in several instances, but the prevailing form of decoration was incised and punctate. A few loop-handles were found. A selection of sherds from this mound is shown in Fig. 88.

In this mound were several large fragments of shell-tempered ware, belonging to one vessel, the first we recall having met with in peninsular Florida, if we except two handsomely made bird-head handles from the Island of Marco, which had been worn as pendants, and were, doubtless, importations. Even on the Florida mainland shell-tempered ware is rarely met with until the district bordering Alabama is reached.

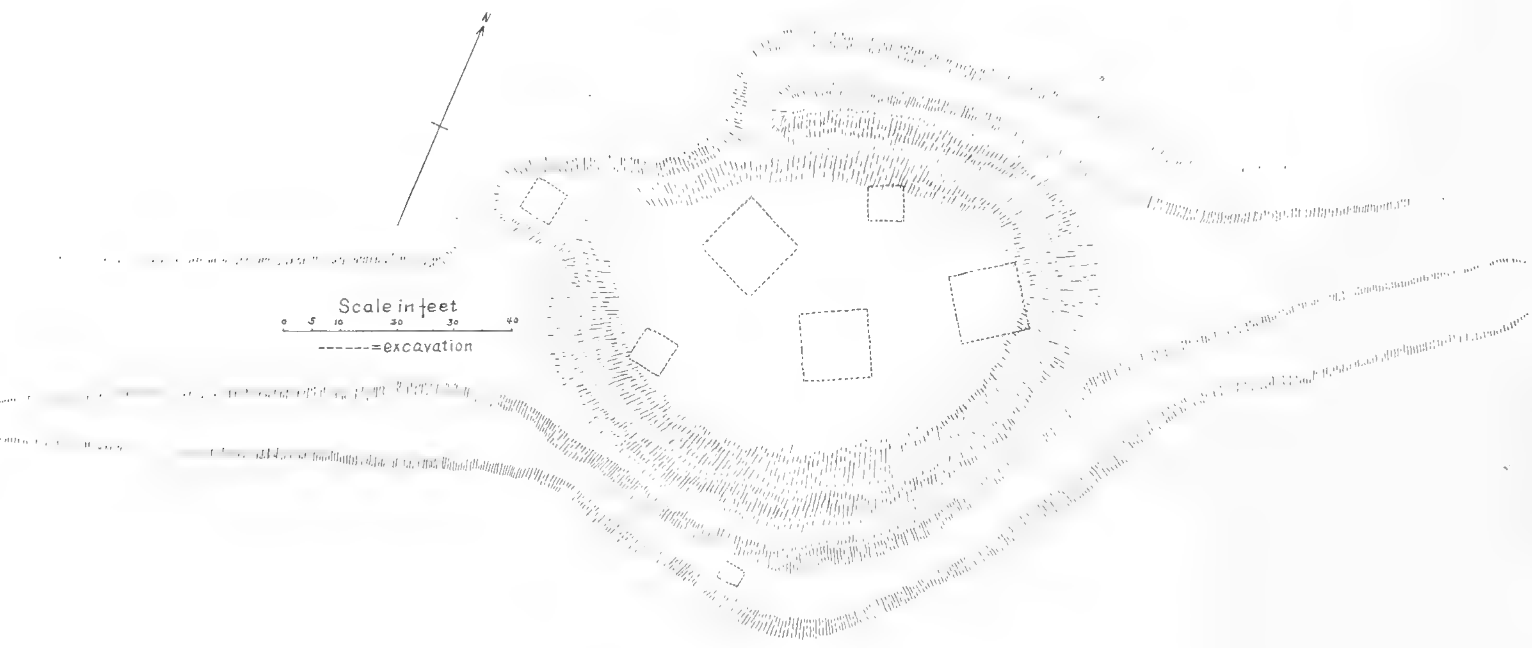


FIG. 89.—Plan. Mound on Long Key.

MOUND ON LONG KEY, HILLSBORO COUNTY.

Long Key lies between the Gulf and Boca Ceiga bay, having Blind Pass on the north and Passe a Grille on the south.

About midway from the extremities of the island, a strip of land makes into the bay in a SE. direction. About one-half mile from the end of this strip, in thick growth, is the mound, to which only good luck or a guide can lead one.

The mound is described by Mr. S. T. Walker (*op. cit.*, pg. 403, *et. seq.*) who also gives a plan of it, and ascribes to it the form of a turtle. In Fig. 89 we give

the plan of the mound as it seemed to us. The material is white sand; the height somewhat under 4 feet. The length is 100 feet; the maximum breadth, about 70 feet.

Three holes, each 12 feet square, and three others, each 6 feet square, were dug by us. In several places was sand tinged with hematite and one skeleton closely flexed on the left side, about two feet from the surface, was met with. This burial had a recent appearance and impressed us as being intrusive.

No artifact of any sort was found.

For accounts of additional, but unimportant mounds in this district just north of Tampa bay, see our "Antiquities of the Florida West-Coast," Journal of the Academy of Natural Sciences of Philadelphia, Vol. XI.

In the district of which this paper treats was no new form of burial.

Calcined human bones were found upon several occasions, but these were probably connected with other burials as is usually the case when calcined remains are found in peninsular Florida.

No urn-burials were met with, nor had our previous experience in the peninsula led us to anticipate their discovery. Incidentally, the southeasternmost urn-burial we have found in Florida was on Marsh Island, Ocklockonee bay, which belongs to the mainland portion of Florida (see outline map).

Cranial flattening, which Bernard Romans says was practised by the Choctaws, was not seen by us on any skull in the mounds of the central Florida west-coast, though the reader of our reports on the northwest coast will recall that the custom was extensively practised there.

The custom to inter general deposits of earthenware in blackened sand did not obtain along the central west-coast, and the life-form in earthenware was not met with,[1] save in the case of one human effigy-vessel and a very highly conventionalized life-form consisting of six protuberances representing head, tail and four legs. Bird-head handles, however, were found. Loop-shaped handles were met with occasionally and seemingly show the influence of regions farther north.

Ceremonial vessels having, in the body, a number of large holes made before the firing of the clay, were not found along the central west-coast, though, as the reader may recall, they are present in numbers in the mounds of the northwest coast of Florida.

The small check-stamp was everywhere met with, and the complicated stamp was found once as far south as the Pithlochascootie river, which is considerably farther south than it was found by us on the St. Johns river. The complicated stamp, however, varies but slightly in pattern along the central west-coast where but little is met with that does not consist of combinations of concentric circles.

While, as we have stated, the ware, as a rule, was inferior, yet excellent ware with artistic decoration, punctate and incised, was in the possession of the aborigines

[1] Life forms in earthenware are not met with, practically, south of the Warrior river (see outline map).

of the west-coast. Gritty ware and shell-tempered ware, as might have been expected, practically were absent.

The finding of solid copper, a fish-spear along the Suwannee river, and pendants of solid copper in the Crystal river mound, came in the nature of a surprise. Though we had found several large and heavy beads of solid copper along the Ocklawaha river and near the Lakes from which the river runs, and a lance-head of thin copper near the mouth of the St. Johns, yet sheet-copper preponderated to such an extent among our discoveries of copper in Florida, that we had come to regard the territory as being so far distant from the source of aboriginal supply that the material would be used there hardly otherwise than as a veneer. It seems, however, that some solid copper was in use there, and doubtless more will be found as mound-work is continued in the State.

CERTAIN

ABORIGINAL MOUNDS

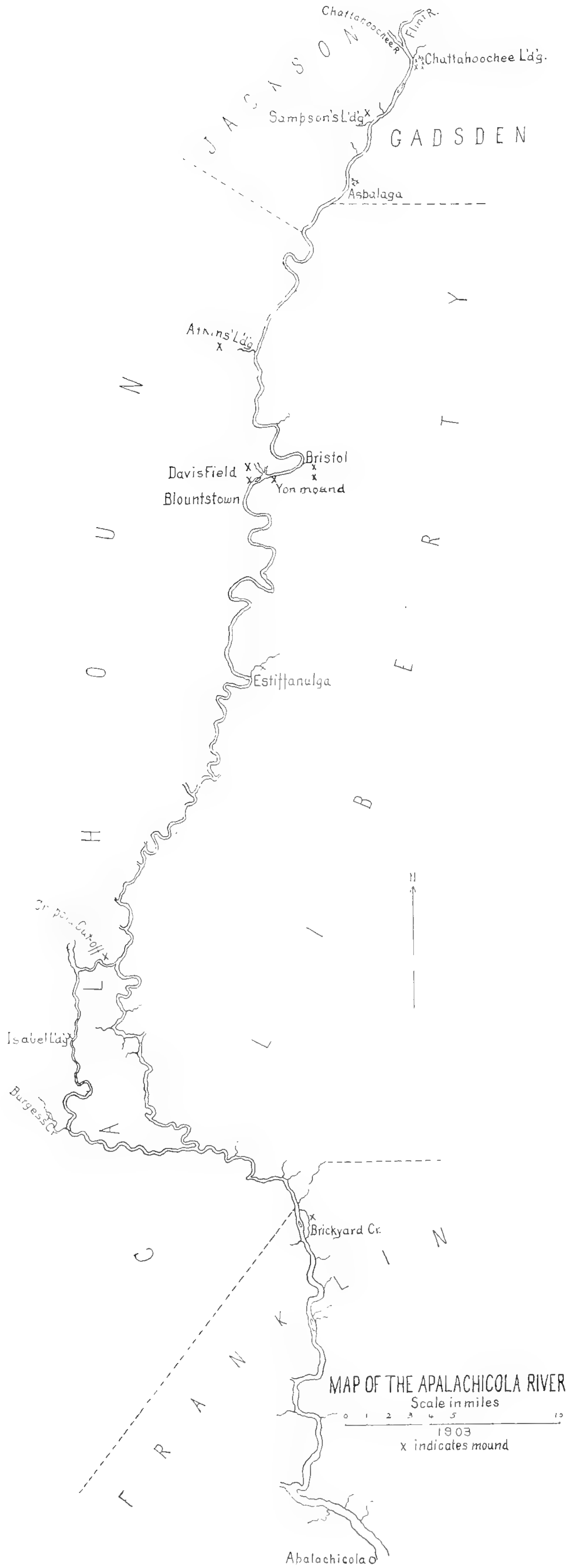
OF THE

Apalachicola River

BY

CLARENCE B. MOORE.

PHILADELPHIA:
1903.


Chattahoochee R.
Flint R.
Chattahoochee L'd'g.
JACKSON
Sampson's L'd'g.
GADSDEN
Asbalaga
Atkins' L'd'g.
Bristol
Davis Field
Blountstown
Yon mound
Estiffanulga
CALHOUN
LIBERTY
N
Isabel L'd'g.
Burgess Cr.
Brickyard Cr.
FRANKLIN
MAP OF THE APALACHICOLA RIVER
Scale in miles
0 1 2 3 4 5 10
1903
x indicates mound
Apalachicola

CERTAIN ABORIGINAL MOUNDS OF THE APALACHICOLA RIVER.

By Clarence B. Moore.

The Apalachicola river, formed by the union of the Chattahoochee and the Flint, at the boundary between Georgia and Florida, keeps a southward course through the Florida mainland and empties into Apalachicola bay, a part of the Gulf of Mexico. The length of the river is about 70 miles in a straight line, and about 105 miles, following the course of the stream.

What we have said as to the reproduction of vessels and as to the preparation of the report, at the beginning of the paper on the mounds of the Florida west-coast, applies equally to this report.

Mounds Investigated.

Mound on Brickyard creek, Apalachicola river.
Mound near Burgess creek, Chipola river.
Mound near Isabel Landing, Chipola river.
Mound near Chipola Cut-off, Chipola river.
Mound near Estiffanulga, Apalachicola river.
Mound near Blountstown, Apalachicola river.
Mound in Davis Field, Apalachicola river.
Yon mound, Apalachicola river.
Mound below Bristol, Apalachicola river.
Mound at Bristol, Apalachicola river.
Mound near Atkins' Landing, Apalachicola river.
Mounds near Aspalaga, Apalachicola river (3).
Mound near Sampson's Landing, Apalachicola river.
Mounds at Chattahoochee Landing, Apalachicola river (7).

In addition to these mounds, we investigated, the previous season, at and near the town of Apalachicola, eleven mounds, full accounts of which are given in our "Certain Aboriginal Remains of the Northwest Florida Coast," Part II.

Mound on Brickyard Creek, Franklin County.

This mound, immediately on the eastern bank of Brickyard creek, about one mile from its junction with the Apalachicola river (see map), on property of Mr. Frank Massina, of Apalachicola, had been dug through and through, previous to our visit.

The mound, probably, had been about 4 feet in height and 35 feet across the circular base, approximately. What was left of the mound was completely demolished by us.

One human femur, badly decayed, one molar and some fragments of bone too small for identification were the only signs of burial met with by us in the mound, though fragmentary human bones lay upon the surface.

There were present, here and there in the mound: two arrow-heads or knives, of chert; two piercing implements of bone; three columellæ of marine univalves, pointed as for use, found together; two pebble-hammers; flakes of chert; a triangular bit of chert, chipped to a cutting edge on one side; a fragment of ferruginous sandstone; mica; an oblong piece of silicified wood, which had seen use as a hone.

Owing to the great amount of previous digging, data as to position of objects in the mound were hard to obtain. However, sherds and piles of fragments of different vessels, placed together, were noted in undisturbed sand in the eastern part of the mound, as we had so often found to be the case in mounds of the northwest Florida coast.

FIG. 91.—Sherd. Mound on Brickyard creek. (Half size.)

FIG. 92.—Earthenware handle of vessel. Mound on Brickyard creek. (Full size.)

There were also in the eastern part of the mound nine vessels of inferior ware, some badly broken, all showing the basal perforation where their condition allowed determination.

Vessel No. 2.—In a sort of pit, in the SE. margin, was an unassociated bowl of about one quart capacity, having an incised scroll-decoration, with punctate markings, in addition.

Vessel No. 4.—A quadrilateral vessel undecorated save for an incised line around the rim.

Vessel No. 5.—A vessel probably representing a section of a gourd cut longitudinally.

Vessel No. 6.—A bowl in fragments, with notches around the rim and four very rude animal heads.

Vessel No. 7.—A vessel badly crushed, having a broad band of complicated stamp-decoration around the neck.

Vessel No. 8.—A bowl of heavy ware, badly broken, covered with crimson pigment, inside and out.

Vessel No. 9.—A quadrilateral vessel with rounded corners and convex base, having for decoration beneath the rim a broken line with an incised line below it.

Among the sherds, the check-stamp was represented as was the complicated stamp, one pattern of which is shown in Fig 91.

Much ware bore incised and punctate decoration of familiar patterns. There were found also a handle representing the head of a duck (Fig. 92) and a small handle, a bird head in profile, having a perforation in place of eyes.

Mound near Burgess Landing, Burgess Creek, Calhoun County.

Chipola river is a tributary of the Apalachicola.

Burgess creek enters the Chipola river on the west side, about eight miles up. Burgess landing, on the west side of the creek, is about one mile above the junction of the creek with the river. The mound, on property of Mr. S. S. Alderman, of Wewahitchka, Florida, was about 100 yards from the landing, in full view from the road.

The mound, much spread by previous digging here and there, had also a narrow trench entirely through it in an eastwardly and westwardly direction. The height of the mound at the time of our investigation, was 4 feet 9 inches; its diameter, 48 feet. Trenches were run in from all sides, a distance of about 3 feet when it became evident that the mound proper, with a diameter of 42 feet, had been reached. The mound, of clayey sand, very tenacious in places, was entirely demolished by us, with the exception of small portions around several trees.

Human remains were not met with until the digging had advanced well into the body of the mound, when, at different points, and especially, near the center, fragments of single skulls and bits of long-bones were found. Once, fragments of a skull lay with the remains of one radius and of one femur. In all, human remains lay in twelve places, but so near together, at times, that some of these may have belonged to the same burial.

No artifacts lay with the bones, but scattered through the mound were: two small "celts" of polished rock, at one place and one at another; four hones of ferruginous sandstone; mica, in two places; a rude arrowhead of chert.

All in the eastern side of the mound, beginning a certain distance in from the margin, were deposits of sherds, often parts of a number of vessels together, and entire vessels, broken and whole. Altogether about two dozen vessels were met with, all of inferior ware, none showing any novelty as to form or decoration. The

majority were undecorated, several had a faint check-stamp. The complicated stamp, faintly impressed, was on one sherd and on one vessel. Rude, punctate decoration was shown on two or three vessels, and a somewhat better executed line and punctate design was on part of a vessel found in three pieces.

Fig. 93.—Vessel No. 5. Mound near Burgess Landing. (Three-quarters size.)

Thirteen or fourteen vessels, mostly pots, some badly crushed, lay in contact one with another.

In cases where the condition of the vessel allowed determination, the hole knocked in the base to "kill" the pot was found to be present.

But two vessels merit particular description.

Vessel No. 2.—A vessel of about three pints' capacity, of elliptical section, with a projection on two opposite sides, perhaps a conventional head and tail, undecorated, save for crimson pigment on the exterior.

Vessel No. 5.—This vessel, found in fragments and since cemented together, with restoration of certain missing parts, including where the tail should be, has for handle the head of a wood-duck (Fig. 93). Upon the vessel is a certain amount of crimson pigment. The base has the usual mortuary mutilation made after the baking of the clay.

Mound near Isabel Landing, Chipola River, Calhoun County.

This mound, about 100 yards west of the landing, on property of Mr. L. M. Ware, of St. Andrews, Florida, had been literally honey-combed by holes and trenches. At the time it was dug down by us, with the exception of parts around certain trees, it had a height of 4 feet 7 inches; a basal diameter of 48 feet.

Though much of the mound still remained intact, especially the lower portion, human remains were found by us but twice: a single skull badly decayed, 3 feet down in the SE. part of the mound; a few bones, probably disturbed by a former trench.

In the eastern part of the mound, near the margin, were a few undecorated sherds and several with the small check-stamp. Farther, in the same direction, here and there, stopping short of the center, were five or six vessels of ordinary type and inferior ware, undecorated, several with parts missing. Among these was a pot with a complicated stamp decoration consisting of squares made up of parallel lines, a pattern found by us on the northwest coast. This vessel had two perforations, one on either side of an early fracture, to permit a cord or sinew to bind the parts together.

All vessels in this mound, of which sufficient remained to allow a determination, had the mortuary perforation knocked through after baking.

There were also in the mound: a sherd with the complicated stamp; one with rude punctate decoration; mica; a flake of chert; a quartz pebble.

Mound near Chipola Cut-off, Calhoun County.

The Apalachicola and Chipola rivers, some miles above their junction, are united by a sort of canal which is called the Chipola Cut-off.

In a swamp, about 40 yards from the bank, on the northern side, near the eastern end of the cut-off, was a mound on property under control of Mr. F. B. Bell, of Wewahitchka, Florida. Between the mound and the water is a considerable excavation whence the material for the mound was taken.

The mound, which had been dug into in almost every direction, had, at the time of our visit, a height of 5 feet 3 inches. The base, circular in outline, was 45 feet in diameter.

The mound, which was totally dug down by us, was composed of brown sand with a certain admixture of clay. The sand in the eastern and southern parts of the mound, where most of the pottery was found, was of a deeper brown than elsewhere. Below the mound was sand seemingly undisturbed, yellow, rather coarse, without admixture of clay.

Burials were noted at forty-two points, and were met with marginally, and throughout the mound to the center, the greater number being in the southeastern, southern and southwestern parts, where the principal deposit of pottery was found, though the pottery was seldom directly associated with burials.

The forms of burial were similar to the majority of those found along the northwest Florida coast, consisting of the flexed skeleton, the bunched burial and the lone skull. The condition of the bones was fragmentary through decay, crania being represented by one calvarium. Upon this no artificial flattening was apparent.

With the burials were a number of artifacts, including several vessels of earthenware, one immediately over a skull; chisels wrought from lips of marine univalves; shell beads, large and small; fifty small shells (*Marginella*) perforated for use as beads; many small, round masses of hematite, perhaps used in a rattle; a number of "celts" of various rocks; two hones of ferruginous sandstone; a number of small, sharp flakes of chert, together; one glass bead from the body of the mound; several columellæ of marine univalves, with pointed ends.

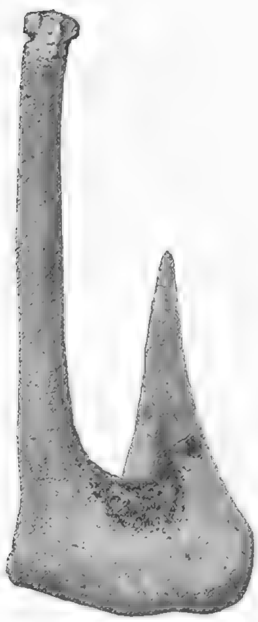


FIG. 94.—Fish-hook of bone. Mound near Chipola Cut-off. (Full size.)

With Burial No. 15, a bunch, were: two large columellæ, each pointed at one end and each having a portion of the shell remaining on the upper part, doubtless to serve as a handle; two shell hair-pins; mussel-shells; one stone "celt;" shells used as beads (*Marginella*); two shell chisels made from lips of marine univalves; two fine shell gouges wrought from the body whorl of *Fulgur;* two bones of a lower animal, probably ulnæ of deer, badly decayed, with the proximal articular parts present, and the distal ends, which, seemingly, had been worked to a point, missing; two tibiæ of the deer, with both ends cut off, doubtless handles; a number of fragmentary implements of bone. With these was a fish-hook of bone (Fig. 94), 3.2 inches in length, having two features not before met with by us in our mound work. The lower end has a part of the articular surface of the bone remaining, and the hook has a well-defined barb. Barbed fish-hooks of aboriginal make are

met with infrequently enough anywhere, but in the southern United States this barbed hook must be almost unique.

Another fish-hook, probably similar to this one, came from elsewhere in the mound. Unfortunately, the point of the hook was broken in removal, and the most careful search failed to recover it.

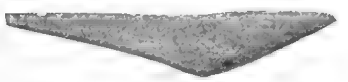


Fig. 95.—Object of bone, probably fish-hook. Mound near Chipola Cut-off. (Full size.)

In Fig. 95 is shown an implement of bone, probably a fish-hook of another variety, found with the fish-hook first described.

This swamp-mound, under water in times of freshet, was somewhat above water-level at the period of our visit. Burial No. 19, consisting of a few fragments of badly decayed bone, lay in a distinctly marked pit, below the base, where the dark-brown, clayey sand of that part of the mound extended into the coarse, yellow sand considerably below the water level. With the bones, and extracted with great difficulty, owing to the rapid filling of the pit with water, were: two vessels of earthenware, one badly broken; a disc of sheet-brass, about 4.5 inches in diameter, without decoration, having two holes for suspension, about .75 of an inch apart, near the margin; a disc of sheet-brass, nearly 8 inches in diameter, also undecorated, having a small hole in the center for attachment.

This disc, which was somewhat broken in removal, still showed traces of fiber in which it had been wrapped, as did the other disc. Also with these objects were three glass beads; doubtless many others were left at the bottom of the pit, since the removal of objects so small, when one is working at arm's-length under water, is a difficult matter.

Burial No. 25, a few bones, lay also in a pit, under water, below the base of the mound. With them were shell beads and a stone "celt."

Burial No. 30, two skulls, had with it a *Fulgur perversum*, 15.2 inches in length, the largest shell of this variety of which we have been able to learn.

With Burial No. 32, bones which fell with caved sand, was a circular ornament of sheet-brass, 4.5 inches in diameter, slightly concavo-convex, without decoration, with a central perforation, somewhat broken, bearing traces of fiber, like the others.

Burial No. 41, a bunch, lay in a pit with Vessels Nos. 48 and 49.

Burial No. 42, the skull of a child, had with it fragments of an undecorated disc of sheet-brass.

Unassociated were: three pebbles; one sandstone hone; several flakes of chert, with cutting edge on one side. There were also many objects of shell, such as we have described as present with burials. These objects, in all probability, though not found with bones, had been with them before disturbance by recent diggers.

Twenty-four "celts" of various rocks, from 2.6 inches to 9.8 inches in length, many with ends gracefully tapering opposite the cutting edge, were present in the mound, some with burials as we have stated, many alone. Certain of these lay in the very margin of the mound and evidently had been placed there ceremonially, since burials were not met with until farther in.

While sounding with an iron rod in and around the burial pits of which we have spoken, a member of the party, with no particular reason, drove the rod through the bright yellow sand which, as we have said, was seemingly undisturbed and underlay the base of the mound. Greatly to our surprise, about 2.5 feet below the level uncovered by our men, which was supposed to be the base of the mound, a solid object was encountered. After much labor, including repeated use of a portable pump, this object was found to be a beautiful chisel or hatchet, of trap rock, 9 inches long and about 3.5 inches in maximum breadth with a maximum thickness of .8 of an inch. This implement, flat on one side, slightly convex on the other, had a well-made cutting edge at the broad end. With this implement were two ordinary "celts." We are at a loss to explain the presence of these objects where they were found. We are loth to believe in the presence of burials beneath the base, unnoticed by us, as a careful lookout was kept by the diggers who had been with us mostly for long periods, and by those having the work in charge. The regular burial-pits found by us, as we have said, were filled with a material differing from the sand into which they extended. Possibly this deposit was a ceremonial one, or a cache made before the building of the mound.

At the very start, all around the margin, but mainly in the S. and SE. parts of the mound, sherds were met with, followed by considerable deposits of various parts of broken vessels, in masses, in no case, however, having a full complement of any one vessel. Near these, occasionally, were single vessels, and later, numbers of vessels together, extending in to the center of the mound—in fact, the same ceremonial deposit of earthenware with which those who have looked over our reports of the mounds of the northwest Florida coast, must be familiar. In this case, however, vessels, to a certain extent, were found with burials, and the ceremonial deposit, in a certain degree, was met with in parts of the mound other than those we have named.

The ware from this mound is, as a rule, inferior, though some is of excellent quality, including certain bowls of black, polished ware, the specialty of Mississippi, which ware we had found before no farther eastward than Choctawhatchee bay (see outline map) where it was, as in the Chipola mound, represented by a few examples, perhaps importations.

Curiously enough, also, other ware from the mound, besides that we have mentioned, recalls ware belonging to more western districts in composition and in finish, while the decoration, largely made up of the scroll, resembles that described in the first part of our report on the mounds of the northwest Florida coast, rather than that of the second part, in which the Apalachicola coast-region is included.

There fell to our portion as gleaners, after the wide-spread, previous digging in this mound, fifty-one vessels, including whole vessels, vessels with but small parts missing, and others, in fragments, where the full complement or almost the complement of the vessel is present.

We shall describe in detail the most notable of these vessels. All, unless otherwise described, have the usual basal mutilation made before the baking of the clay.

Vessel No. 6.—A small bowl notched around the margin, with incised and punctate decoration, as shown in Fig. 96.

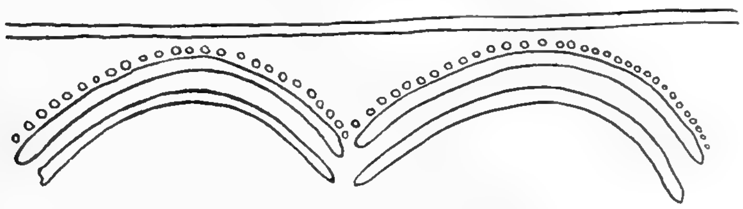


FIG. 96.—Vessel No. 6. Decoration. Mound near Chipola Cut-off. (Full size.)

Vessel No. 7.—A bowl of about one quart capacity, with incised and punctate decoration on the sides and base, shown diagrammatically in Fig. 97.

Vessel No. 8.—A small bowl of inferior ware, oval in section, with a rudely executed bird-head on one side and a rudimentary, conventional tail on the other (Fig. 98). The decoration, incised and punctate, representing wings in part, is shown diagrammatically in Fig. 99, where it has been found impossible to follow an exact scale, owing to the curvature of the base.

Vessel No. 10.—A five-pointed dish of yellow ware, with incised and punctate decoration (Fig. 100).

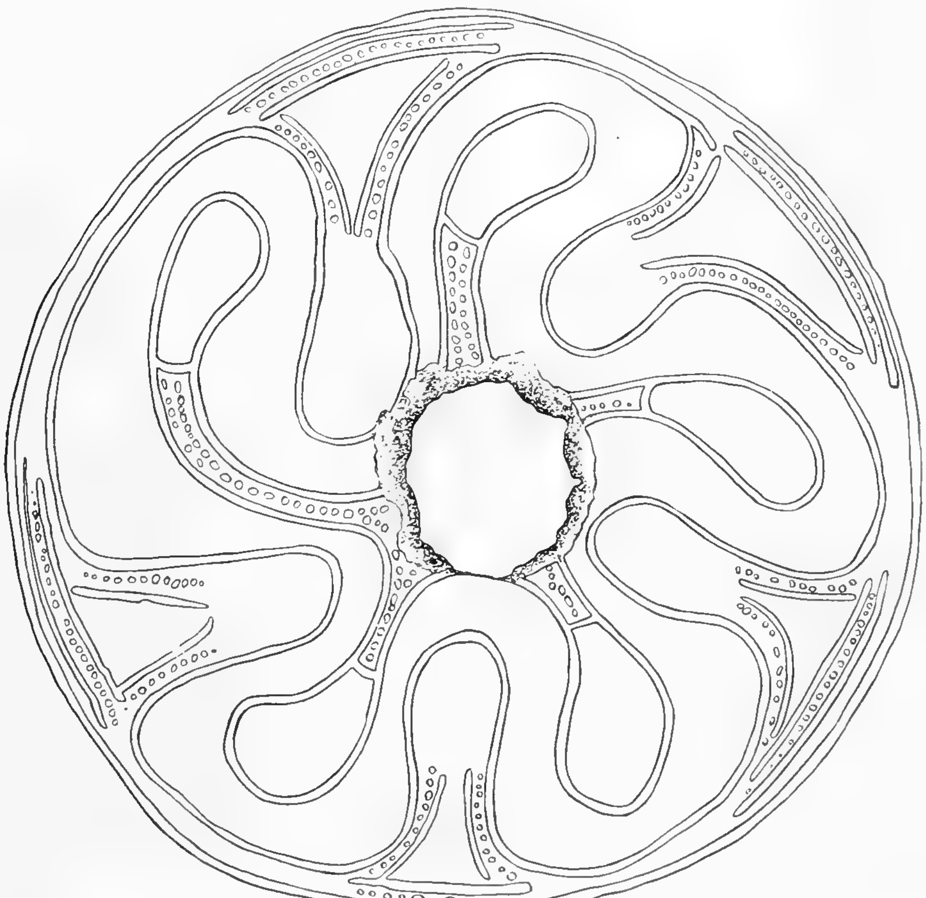


FIG. 97.—Vessel No. 7. Decoration. Mound near Chipola Cut-off. (Half size.)

FIG. 98.—Vessel No. 8. Mound near Chipola Cut-off. (Full size.)

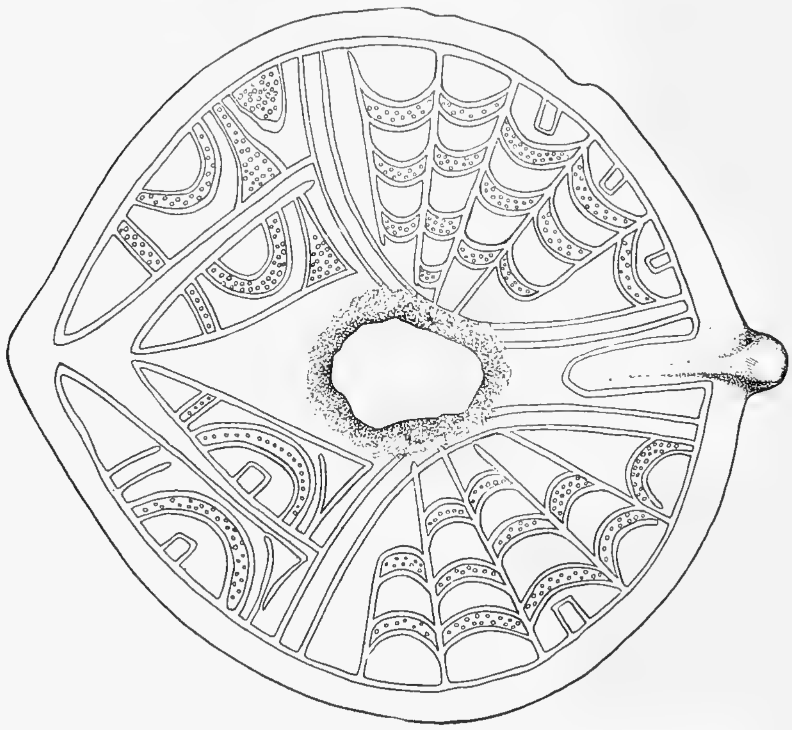


FIG. 99.—Vessel No. 8. Decoration. Mound near Chipola Cut-off. (Not exactly on scale.)

Vessel No. 12.—A bowl of about four quarts' capacity, with notches around the margin, having an incised and punctate design six times repeated (Fig. 101).

Vessel No. 13.—Has for decoration upright, parallel lines between two encircling, parallel lines.

Vessel No. 14.—A bowl of about five pints' capacity, of inferior ware, having a

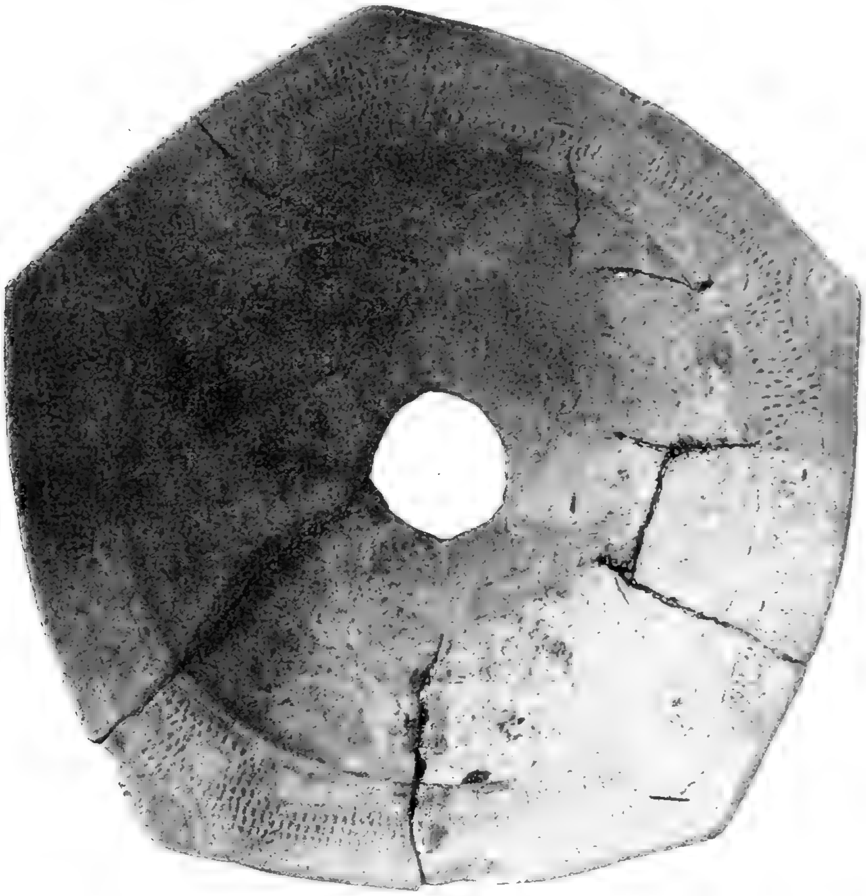


FIG. 100.—Vessel No. 10. Mound near Chipola Cut-off. (Half size.)

FIG. 101.—Vessel No. 12. Mound near Chipola Cut-off. (About three-quarters size.)

scalloped margin. On the seven apices of the scallops have been an equal number of small, rude animal-heads, all but one of which are missing.

Vessel No. 15.—A vase of yellow ware (Fig. 102), with incised and punctate decoration shown in diagram (Fig. 103).

Vessel No. 16.—A dipper representing a section of a gourd. There is rude, incised decoration in which the scroll figures.

Vessel No. 20.—This interesting, mortuary vessel, 13.25 inches in height, 8.75 inches in maximum diameter (Fig. 104), with upright bird-head handle, was not represented in the mound by its full complement of parts. Such portions as were missing have been restored, but in no case has any opening been introduced, unless

Fig. 102.—Vessel No. 15. Mound near Chipola Cut-off. (About five-sixths size.)

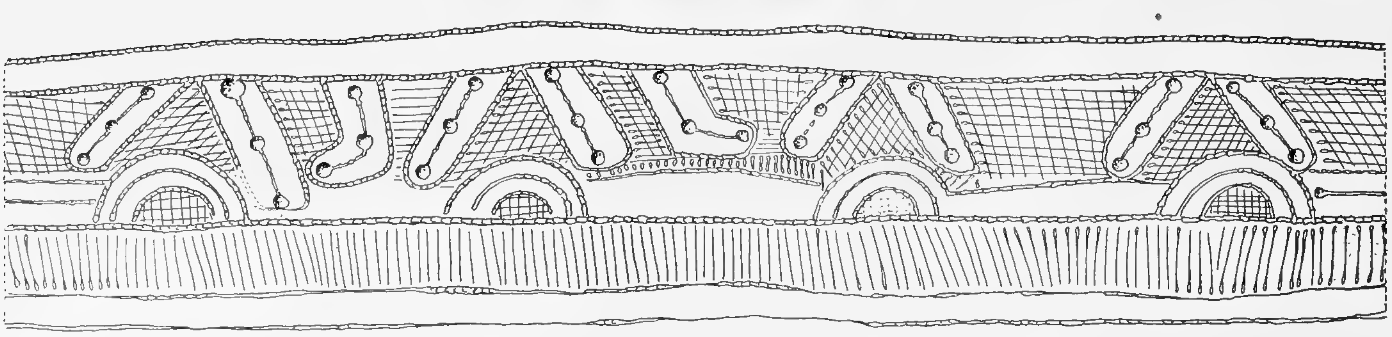


Fig. 103.—Vessel No. 15. Decoration. Mound near Chipola Cut-off. (Half size.)

its former presence was clearly indicated by marginal parts. Nearly the entire base has been broken out.

Vessel No. 21.—A water-bottle of coarse ware, with uniform incised and punctate decoration, in which the partly interlocked scroll is prominent (Fig. 105).

Vessel No. 22.—A handsome dipper, modelled after a section of a gourd, of

FIG. 104.—Vessel No. 20. Mound near Chipola Cut-off. (Half size.)

Fig. 105.—Vessel No. 21. Mound near Chipola Cut-off. (About four-fifths size.)

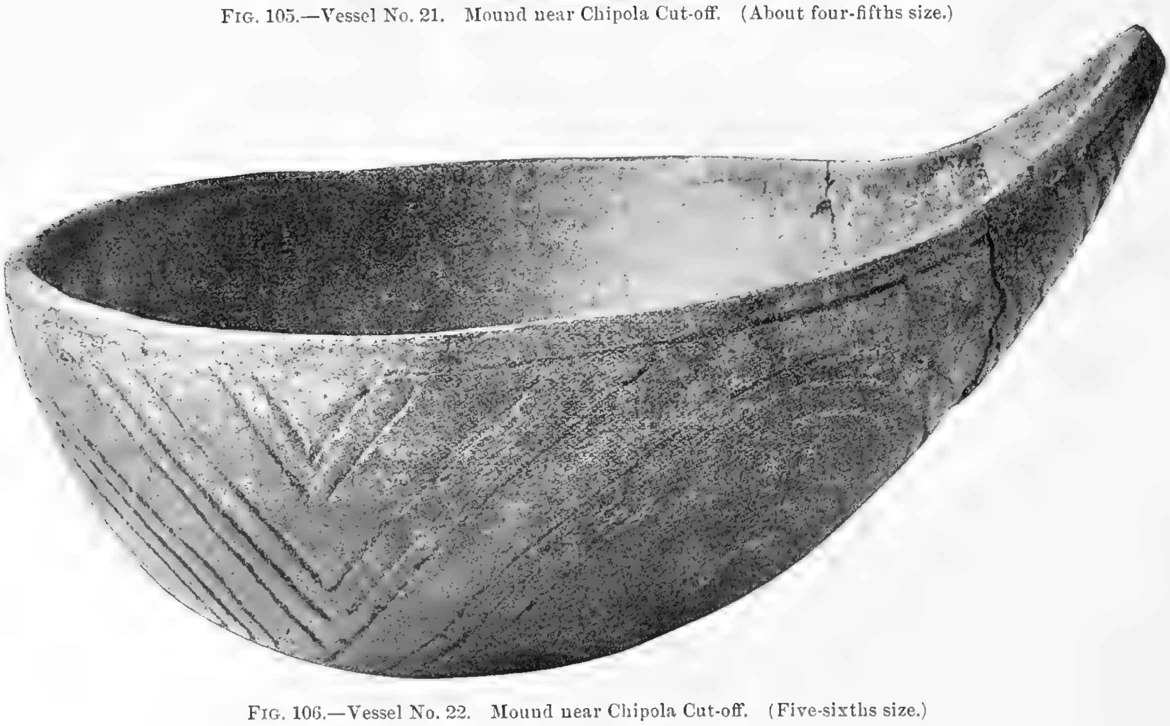


Fig. 106.—Vessel No. 22. Mound near Chipola Cut-off. (Five-sixths size.)

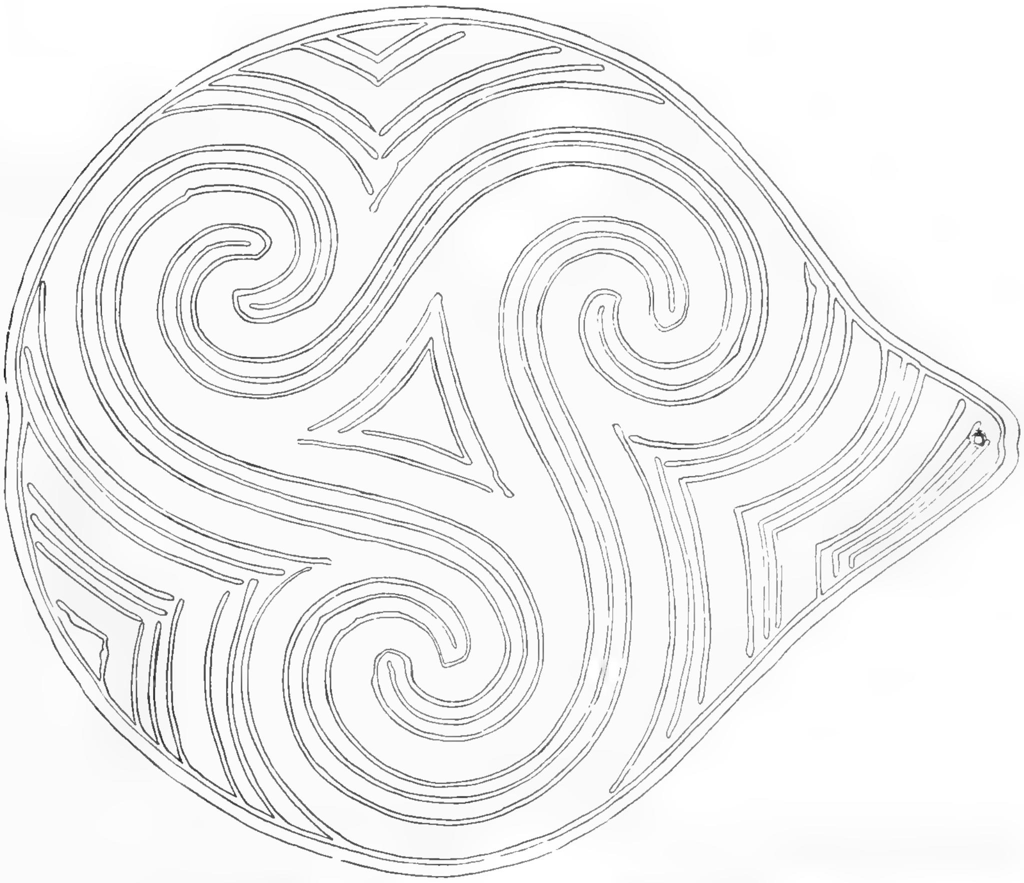


FIG. 107.—Vessel No. 22. Decoration. Mound near Chipola Cut-off. (Not exactly on scale.)

FIG. 108.—Vessel No. 24. Mound near Chipola Cut-off. (About two-fifths size.)

black, polished ware, recalling that of Mississippi (Fig. 106), with the entire body and base covered with incised decoration in which the scroll is prominent, shown diagrammatically in Fig. 107. At the end of the handle is a small hole for suspension. The basal perforation is absent.

Vessel No. 24.—A bowl 7.5 inches high and 12.8 inches in maximum diameter, with a uniform decoration (Fig. 108).

Fig. 109.—Vessel No. 26. Mound near Chipola Cut-off. (Four-sevenths size.)

Vessel No. 26.—This vessel, of heavy but coarse ware (Fig. 109), notched around the rim, has for decoration incised crosses on two opposite sides and incised, partly interlocked scrolls on the other two. Other decoration, seemingly punctate, proves, on examination, to have been done with a stamp. One-half the decoration, almost a repetition of the other half, is shown diagrammatically in Fig. 110.

Vessel No. 28.—A compartment vessel originally consisting of a square com-

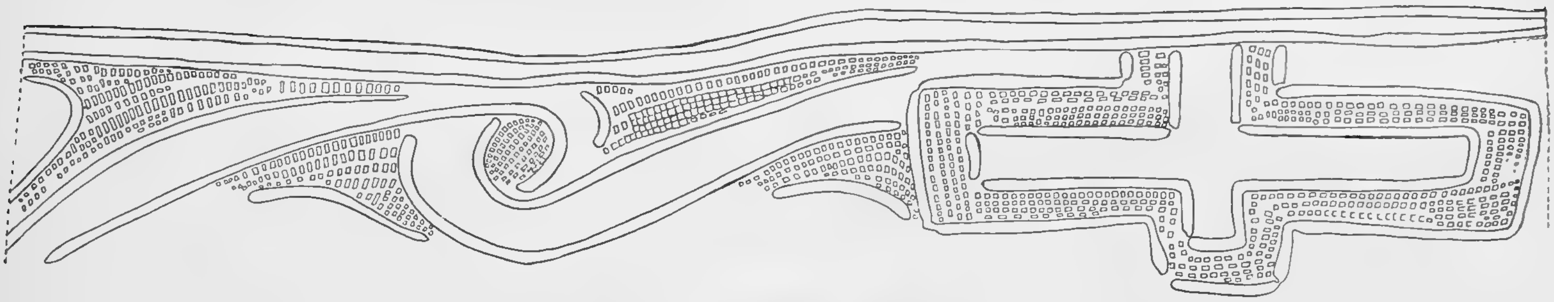


FIG. 110.—Vessel No. 26. Decoration. Mound near Chipola Cut-off. (Half size.)

FIG. 111.—Vessel No. 28. Mound near Chipola Cut-off. (About three-fourths size.)

FIG. 112.—Vessel No. 29. Mound near Chipola Cut-off. (Full size.)

partment with round ones on three sides. One of these, missing when the vessel was found, has been restored (Fig. 111).

Vessel No. 29.—This diminutive, imperforate vessel, with semi-globular body and upright neck slightly expanding, having small holes on opposite sides for suspension, is but 2.2 inches in height (Fig. 112). The incised decoration, shown diagrammatically in Fig. 113, evidently represents two eyes and a nose on one side and probably hair on the other. The decoration around the neck of the vessel is not so readily determined.

Vessel No. 32.—An imperforate vessel of about two quarts' capacity, notched around the

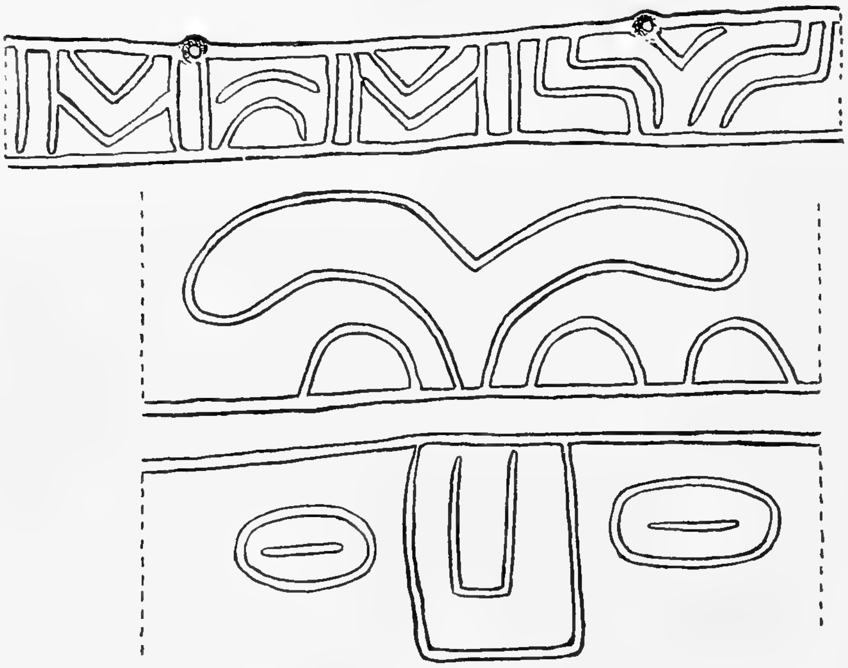


Fig. 113.—Vessel No. 29. Decoration. Mound near Chipola Cut-off. (Full size.)

Fig 114.—Vessel No. 32. Mound near Chipola Cut-off. (About three-fourths size.)

rim, which has, in addition, four upright protuberances, probably rudimentary animal heads (Fig. 114).

Vessel No. 33.—This vessel has notches around the rim and an incised decoration of animal paws and partly interlocked scrolls below (Fig. 115).

Vessel No. 34.—A bowl with incised decoration shown in Fig. 116.

Vessel No. 35.—This vessel, with rather rudely incised decoration, is shown in Fig. 117.

Vessel No. 36.—An imperforate bowl of polished, black ware, with a small bird-head at one side and the conventional tail at the other (Fig. 118). The incised decoration is shown diagrammatically in Fig. 119.

Vessel No. 37.—A broad-mouthed, imperforate water-bottle of dark ware seem-

Fig. 115.—Vessel No. 33. Mound near Chipola Cut-off. (About five-sixths size.)

FIG. 116.—Vessel No. 34. Mound near Chipola Cut-off. (About two-thirds size.)

FIG. 117.—Vessel No. 35. Mound near Chipola Cut-off. (About two-thirds size.)

FIG. 118.—Vessel No. 36. Mound near Chipola Cut-off. (Full size.)

FIG. 119.—Vessel No. 36. Decoration. Mound near Chipola Cut-off. (Not exactly on scale.

ingly tempered with pounded shell, in every way resembling a type found much farther to the westward.

Vessel No. 38.—A vessel of heavy ware, lenticular in section, undecorated save for one encircling, incised line below the rim.

Vessel No. 41.—A pot with complicated stamp-decoration (Fig. 120).

Vessel No. 42.—A small bowl with a complicated stamp faintly impressed.

Vessel No. 47.—A jar with a complicated stamp-decoration around the neck.

Vessel No. 49.—A vessel with incised decoration of a pattern frequently encountered in this mound (Fig. 121).

Fig. 120.—Vessel No. 41. Mound near Chipola Cut-off. (Five-sixths size.)

Among the masses of fragments in the margin of the mound were many large portions of bowls, four of which are shown in Figs. 122, 123, 124, 125.

In Fig. 126 is shown part of a bowl with the head of a fish in profile.

In Fig. 127 is shown a part of a vessel with the neck divided into two parts before joining the body, a type not met with by us before in Florida, but well-known elsewhere, including Missouri, Tennessee and Peru.

Many loop-shaped handles were present in the mound and a considerable number of handles representing heads of quadrupeds and of birds. A selection of these is shown in Fig. 128.

Three stopper-shaped objects of earthenware came from this mound, one with a central depression in the top, and an encircling line of impressions made by a triangular point, around the margin (Fig. 129).

Fig. 121.—Vessel No. 49. Mound near Chipola Cut-off. (Five-sixths size.)

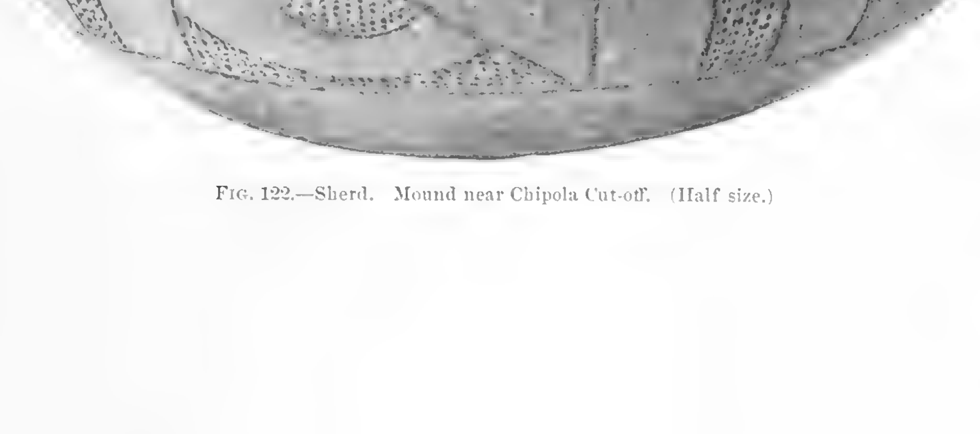


Fig. 122.—Sherd. Mound near Chipola Cut-off. (Half size.)

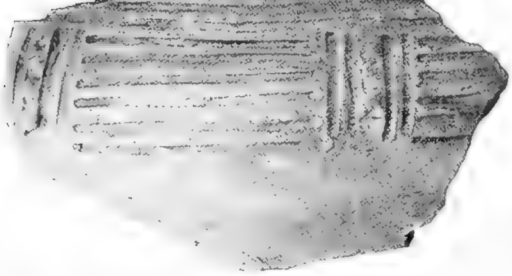


Fig. 123.—Sherd. Mound near Chipola Cut-off. (Half size.)

Fig. 125.—Sherd. Mound near Chipola Cut-off. (Half size.)

Fig. 124.—Sherd. Mound near Chipola Cut-off. (One-third size.)

Fig. 126.—Mound near Chipola Cut-off. (Full size.)

Fig. 127.—Sherd. Mound near Chipola Cut-off. (Full size.)

FIG. 128.—Handles of earthenware vessels. Mound near Chipola Cut-off. (Full size.)

This mound was distinctly a post-Columbian one. Glass came from below the base, and brass was met with in it in three different places. Presumably, previous diggers had removed other objects of European provenance. The reader is urged to contrast this mound with that near the great shell-heap on Crystal river, described in the paper preceding this, where, among hundreds of objects, nothing indicating a European origin was found. In that mound the copper found was native copper, which, by analysis, can readily be distinguished from the impure results of the smelting processes formerly in vogue in Europe, by which copper was recovered from arsenical, sulphide ores. Much of the so-called sheet-copper traded with aborigines by Europeans is in reality brass. If any repoussé or open-work designs, such as are found on native copper in many of the larger mounds which contain no objects admittedly of European provenance, have been found on either sheet-brass or on sheet-copper of the impure kind furnished by Europeans, it has eluded our most careful inquiries.

Fig. 129.—Stopper-shaped object of earthenware. Mound near Chipola Cut-off. (Full size.)

Mound near Estiffanulga, Apalachicola River, Liberty County.

This mound, in pine woods, about one mile in a NE. direction from Estiffanulga, on property of Hon. Thomas Johnson, resident near that place, had been dug into in but a very superficial way prior to our visit. Its height was 3 feet; its basal diameter, 38 feet. The mound, composed of yellow, clayey sand, was totally demolished by us, with the exception of small portions around certain trees.

Human remains were met with but once, 4 feet down, in the center of the mound, in white sand with intermingling of bits of charcoal. The burial consisted of decaying remnants of a lower jaw, two femurs, one tibia.

In the southwestern slope was a rather graceful, spheroidal vessel of fairly good ware, undecorated, with a thickening of rim which projects slightly outward. The usual basal perforation is present.

In the eastern margin was a bowl with perforate base, bearing a small check-stamp.

There were several fragments of undecorated vessels and undecorated vessels in fragments, about the mound, also one sherd with a complicated stamp-decoration.

Separately, here and there in the mound, were three graceful "celts" of various rocks, and another "celt" which, seemingly, had been used to smooth or to polish

with, as a surface about .75 of an inch in breadth was present where the cutting edge had been.

There were also in the mound three arrowheads or knives, of chert, one somewhat broken, and one large, round pebble.

Mound near Blountstown, Apalachicola River. Calhoun County.

About one mile in a NE. direction from Blountstown Landing, a short distance in from the river, is a mound whose southeastern side, facing the water, is on the edge of a terrace along which the river runs in time of flood (see plan, Fig. 130). Much of this side of the mound has been eaten away by freshets, leaving it almost perpendicular.

The mound, on property of Mr. George W. I. Landau, of Patterson, N. J., does not owe its irregularity of shape entirely to the action of the river. The summit plateau slopes gently down from the side bordering the water, and has a maximum height of 19.5 feet, or 2 feet more than the opposite side. On the plateau are the remains of a live-oak, part of which has fallen through decay. The upright portion, 5 feet from the ground, is 16 feet in circumference.

On the side farthest from the water is a small, graded way reaching from the level ground to the summit plateau.

Fig. 130.—Plan of mound near Blountstown.

When our representative located this mound, previous to our visit, through some error the name of the rightful owner was not obtained, and, at the time of our visit, on account of the owner, in his absence, having a watchful representative on the spot, we were unable to investigate. Full permission to dig reached us after our departure. However, the mound was doubtless domiciliary, as indicated by its shape and by the section laid bare by the river, which showed neither bone nor artifact.

Mound in Davis' Field, Apalachicola River, Calhoun County.

About one mile in a northeasterly direction from Blountstown is Davis' Field, long under cultivation in time gone by, but now covered with a sprinkling of pine and other trees, on property of Hon. F. M. Yon, of Blountstown.

The mound, which had been much ploughed over and considerably spread, bore trace of but little previous digging. Its height was 4.5 feet; its basal diameter, considerable of which, however, was due to former cultivation, was 70 feet.

Fourteen trenches were dug inward by us from the margin of the mound, as found by us, until the original margin, presumably, was reached, when what remained of the mound, with a diameter of about 50 feet, was completely dug down, with the exception of small parts around several large pine trees.

The mound, circular in outline, was made of clay having a small admixture of sand, with here and there, small layers and pockets where clayey sand predominated. Throughout, at various points, were more or less charcoal and several fireplaces of considerable size. In the northern part of the mound, extending inward ten feet along the base, with a maximum width of 6 feet and a maximum height of 3 feet, was a mass of fire-hardened clay, red from the effect of heat. Curiously enough, while, here and there, a bit of charcoal lay near this mass, the amount present seemed disproportionately small considering the extent and duration of fire necessary to produce such an effect.

The burials in this mound, which were hardly of more consistency than would be damp sawdust compressed, were met with in twenty-six places. Many of these were found on or near a central space showing marks of fire, and probably belonged to a general interment made at the same time. We shall refer to this matter, later.

The first burial, a few small bits of bone, was met with in the eastern part of the mound at what probably was the original margin. This burial lay near a deposit of earthenware but may have had no connection with it.

The next burial, fragments of a femur, lay in the NW. part of the mound, much farther in than the first burial. After this, burials consisting of the bunch, single skulls, fragments of long-bones, etc., continued to be met with until well in toward the center of the mound, after which flexed skeletons alone were found, beginning with Burial No. 15. Several lay in shallow pits below the base of the mound.

With no burial was an artifact immediately associated, with the exception of a

shell drinking-cup found with the skeleton of a child. Certain sheets of mica, one with a small circular hole in the center, were found near earthenware vessels, and were probably put into the mound ceremonially, as were the vessels.

Toward the center of the mound, somewhat above the base, was an area perhaps about twelve feet square, consisting of masses of charcoal, over and under burials, and in one place bark seemingly with no mark of fire, two thicknesses in one place, three, in another. This layer of bark, 40 inches long and about 2 feet wide, had at one end, at right angles to it, the remains of a log about 6 inches in diameter and about 3 feet in length. Both bark and log were little more than dust. This bark layer lay above a skeleton. The burials under charcoal and under bark were not contiguous, but being on the same plane and near each other, it is probable this area, with its flexed burials, was created at one time and served as a nucleus for the mound.

FIG. 131.—Vessel No. 1. Mound in Davis' Field. (About three-quarters size.)

Vessel No. 1.—Almost due east, probably where the original margin of the mound was, lay a vessel in fragments, with traces of red pigment, inside and out, and a space where a bird-head handle had been (Fig. 131). In the base is a circular hole made before the baking of the clay and, in the body of the vessel, are openings made at the same time. In Fig. 132 is shown diagrammatically the incised and punctate decoration on the wings and on the tail, that on each wing to the left, on the tail to the right. Here we have a ceremonial vessel such as was frequently met with by us along the northwest coast of Florida between St. Andrew's bay and the Warrior river (see outline map).

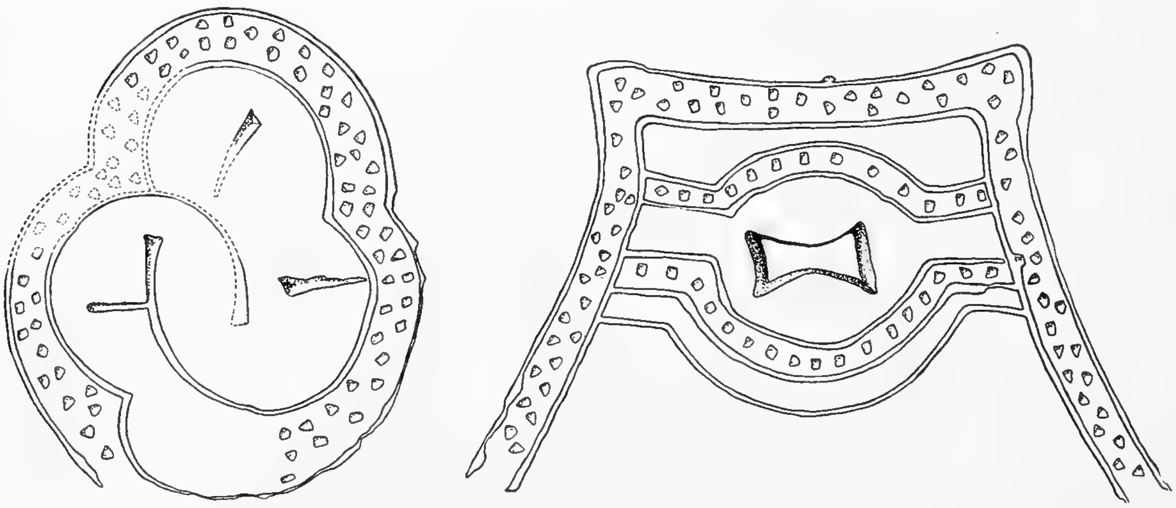


FIG. 132.—Vessel No. 1. Decoration. Mound in Davis' Field. (Half size.)

Vessel No. 2.—Near Vessel No. 1 lay a mass of fragments, a mixture of sherds and parts of vessels, also several undecorated vessels badly crushed. Several feet on either side of this deposit were parts of vessels or possibly whole ones which had been broken and scattered. Certain fragments from this material, cemented together, with slight restoration at places, are shown in Fig. 133. With these fragments was a small, earthenware head of an owl which, like the vessel, which is colored with red pigment inside and out, bore traces of crimson paint. We have tried in vain to find a connection between the head and the vessel. This vessel belongs strictly to the ceremonial class, having body perforations and a basal hole, made before the clay was "fired."

FIG. 133.—Vessel No. 2. Mound in Davis' Field. (One-third size.)

Vessel No. 3.—This vessel, of graceful form, but of inferior ware, as are practically all vessels in Florida, especially made for interment with the dead, is a bird-effigy of the ceremonial class, with a perforation in the base and others in the body, all made before the baking of the clay (Fig. 134). In the body of the bird, but not shown in the figure, is a triangular hole above the tail and a small circular one below

FIG. 134.—Vessel No. 3. Mound in Davis' Field. (About half size.)

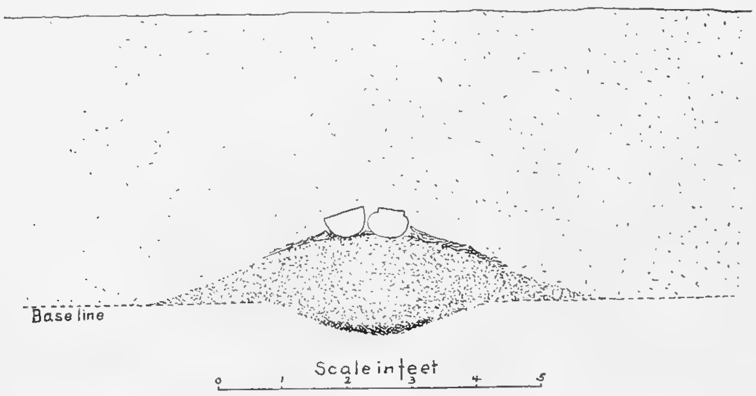


FIG. 135.—Section of ceremonial mound. Mound in Davis' Field.

FIG. 136.—Vessel No. 15. Mound in Davis' Field. (About half size.)

it. This vessel, found in fragments, has been cemented together. The bill, unfortunately, is missing. An incised decoration on the body of the bird has become faint through the inferiority of the ware.

Seven feet farther in, in the same direction, was a most interesting ceremonial deposit. A pit 6 inches in depth and 3 feet 6 inches in diameter had been dug below the base of the mound. On the bottom of this pit lay charcoal where, evidently, a fire had been. Rising above this pit 1.5 feet from its base was a mound composed of clay blackened with fragments of charcoal. This mound was much spread at its base, where it was 7 feet in diameter (see section, Fig. 135). The main body of the mound rose from the center of the basal portion. From the top of this mound of blackened clay to the surface of the mound proper was 3 feet 6 inches. On the apex of this small, ceremonial mound were three vessels, two being visible when the mound was come upon from the eastward, as is shown in the section. These vessels, which fell into fragments when removed, were bowls with thickened rims, covered with crimson pigment, inside and out. One

had, for a handle, a rude representation of a head of a quadruped; another, a place where a head of some sort had been. One had had a hole knocked through the base; the others were too fragmentary to allow determination.

One of these vessels, in addition to the crimson pigment of which we have spoken, bore a complicated stamp-decoration, the first example of this combination in all our mound work, we believe.

On the sides of the small, ceremonial mound were large fragments of earthenware and two shell drinking-cups, badly broken.

Considerably nearer the center, but in the same line with the rest of the earthenware, were twelve jars, pots and bowls, all of ordinary type and all showing the basal perforation, when not too badly broken. Some were undecorated; some had bands of complicated stamp-decoration; one or two were covered with it. All but two were badly broken, some being crushed into minute fragments.

One vessel (No. 15), of eccentric form (Fig. 136), originally covered with red pigment, inside and out, had about one-third, which included almost the entire upper portion, missing. Certain fragments from this portion served as a sure indication for restoration. The usual hole knocked through the base is present.

With the exception of the mortuary deposit running in from the eastern part of the mound, not a sherd was met with, to our knowledge, in the entire mound.

Yon Mound, Apalachicola River, Liberty County.

This fine mound, about two miles below Bristol, in full view from the river, on property belonging to Hon. F. M. Yon, of Blountstown, Florida, is square in outline, with rounded corners at the present time. The basal diameter of the mound is 157 feet. The height depends much upon the side from which the mound is examined, as the surrounding country is irregular, probably 29 feet may be considered the most accurate measurement. There is no graded way and the slope of the sides is steep, as the mound, of hard clay, seems to have washed but little since its making. Two determinations, not especially selected, gave angles of ascent of 38 degrees and 43 degrees, respectively. The diameter of the summit plateau is 68 feet.

This mound gave every evidence of being domiciliary but, as we have sometimes found burials in the summit plateaux of domiciliary mounds,[1] many trenches were dug in the plateau of the Yon mound, resulting in the discovery of one small bunch of human remains, some fragments showing marks of fire.

Mound below Bristol, Apalachicola River, Liberty County.

This mound, in an old field, about one mile in a WSW. direction from Bristol, on property belonging to Mr. Robert Shuler, of that place, was of sand, circular in outline, with a basal diameter of 50 feet. Its height was 3 feet 5 inches. No previous digging was noticeable in this mound.

[1] For example: the Shields' mound, near the mouth of the St. John's river, Florida; the mound at Matthews' Landing, Alabama river; the mound on Perdido bay and the one on Santa Rosa sound, Florida.

Fifteen trenches dug in from beyond the apparent margin indicated the advisability of joining these trenches to include an area of 50 feet in diameter E. and W. and 46 feet N. and S. This portion of the mound was completely demolished by us, with the exception of certain parts around three trees of considerable size.

Almost at the western margin of the mound, in a pit below the base, were a fragment of a cannon bone of a deer and an earthenware smoking-pipe of ordinary shape. With these were three gouges wrought from the body whorl of *Fulgur*. No human remains lay with these relics, though, no doubt, a burial had been there. In the entire mound human remains were found but once and were represented by a fragment of cranium, which lay with a bit of deer bone in what seemed to be the run-way of a small rodent.

Unassociated in the mound were: a rude arrowhead or knife, of chert; one pebble; a pitted stone about 6 inches square.

Almost at the outset, several sherds having the small check-stamp were met with in the SE. part of the mound. Soon after, three vessels were found, and about 3 feet farther south, on line with the others, twenty-one vessels were grouped together. Near these, a little farther in, were four additional vessels. After these, still continuing toward the center, the area of deposit, widening by a few feet, yielded eighteen vessels, singly and in pairs, until the central part of the mound was reached, making forty-six in all. With these was one shell drinking-cup. There were no masses of sherds such as are usually found in ceremonial deposits of this sort.

Never has it been our fortune to open a mound where a number of vessels presented so low an average of excellence. The ware was of the poorest quality. In form, the vessels, mostly pots, offered not a single departure from ordinary varieties. Incised decoration was unrepresented, the sole ornamentation being notches and scallops, and faint and carelessly-applied complicated stamps on three or four vessels and on one sherd. Not a vessel was recovered whole, though the sand was comparatively dry and almost free from roots, where the vessels were. Some were crushed through inferiority of ware, others had been put into the mound with portions missing. All, where determination was possible, showed the basal perforation made after baking.

Mound at Bristol, Apalachicola River, Liberty County.

This mound, in woods, about 300 yards in a NW. direction from the town of Bristol, on property of Mr. J. E. Roberts, of that place, was on the slope of a ridge of sand. The mound rose about 2.5 feet above the level of the ridge and extending down the slope, gained several additional feet in depth. The mound, which was of sand and circular in outline, had a basal diameter of 56 feet. A trench, 10 feet across, dug prior to our visit, extended from the NE. margin 30 feet into the mound. Trenches beginning in the level ground were dug into the mound from all sides a distance of 3 feet, when, it having become apparent that the original mound had been reached, the trenches were joined and the remainder of the mound, with a diameter of 50 feet, was entirely dug down.

Fourteen burials were met with by us, the majority deep in the mound, one being 5 feet 4 inches from the surface. These burials lay throughout the mound, and were characterized by the paucity of bones constituting a burial, the upper half of a skeleton being the largest interment met with. Ten burials consisted of single skulls or skulls associated with a few minor bones. Other burials were: the upper half of a skeleton; part of a thigh bone; two skulls with a tibia and a femur; a femur and a tibia.

Burials Nos. 1 and 2, a skull with cervical vertebræ and clavicle, and the upper half of a body, respectively, each had neatly rounded shell beads of moderate size, at the neck. These were the only artifacts present with burials. Unassociated, 4 feet down, was a small, waterworn boulder about 8 inches long by 9 inches wide, shaped somewhat like a "celt," which, possibly, had seen service as a maul. A sheet of mica, rudely given the shape of a spearpoint, fell in caved sand.

Fig. 137.—Vessel No. 1. Mound at Bristol. (About three-fifths size.)

Almost due east, beginning about 3 feet from the margin of the mound, a point probably marking the original margin, was the usual deposit of earthenware, which continued in to the center, extending but little to either side. The deposit began with a considerable number of sherds and fragments of large vessels, also complete vessels in fragments, nearly all bearing the small check-stamp. Farther in, this decoration was entirely supplanted by other varieties. Here and there, throughout the earthenware deposit, were shell drinking-cups in fragments.

Seventeen vessels were noted by us as complete or nearly so, with the exception of the basal perforation. Many of the vessels, broken and scattered throughout the mound, a custom which was widely practised along the northwest Florida coast, have not been included in our list. These vessels, however, presented no feature of particular interest.

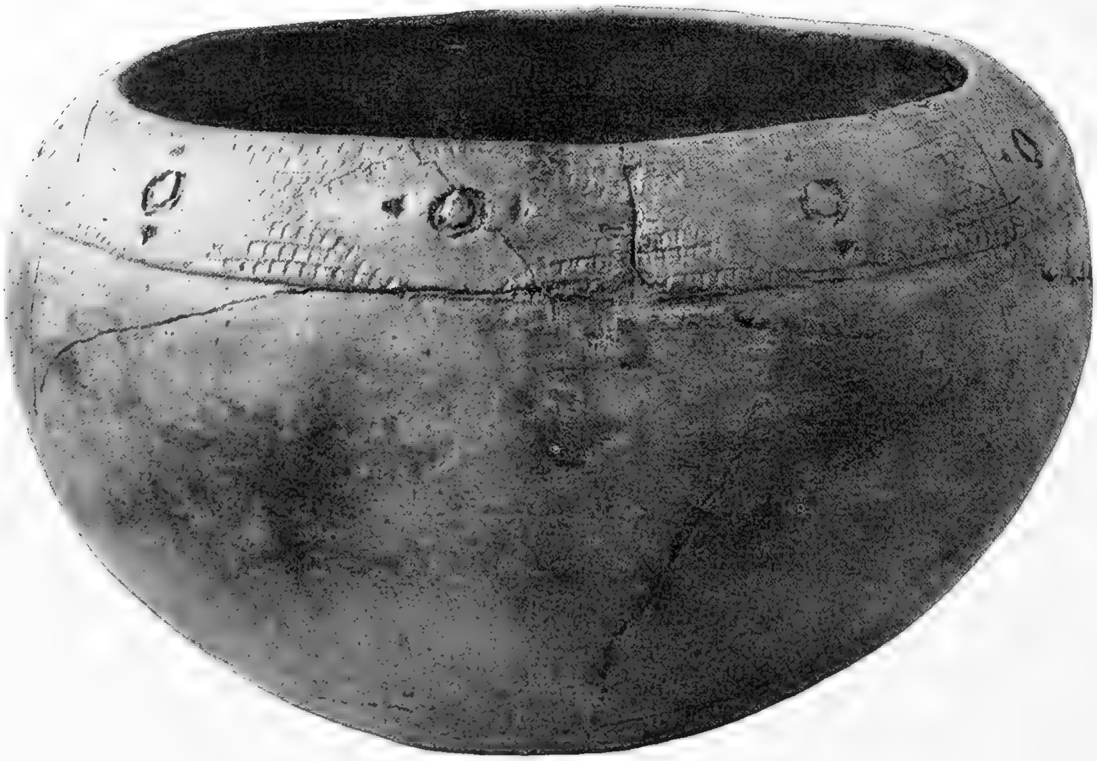


FIG. 138.—Vessel No. 2. Mound at Bristol. (Half size.)

FIG. 139.—Vessel No. 3. Mound at Bristol. (Half size.)

We shall now describe in detail the most interesting vessels from this mound.

Vessel No. 1.—Has a semiglobular body with a long, upright neck, first contracting, then flaring. The decoration is the small check-stamp. A hole has been knocked through the base (Fig. 137).

Vessel No. 2.—A bowl of excellent ware, 11.25 inches in diameter, 7 inches

FIG. 140.—Vessel No. 8. Mound at Bristol. (About four-fifths size.)

FIG. 141.—Vessel No. 10. Mound at Bristol. (About three-fifths size.)

high, in fragments when found, has been cemented together, with a certain amount of restoration (Fig. 138). Below the rim is a series of designs, probably representing the eye.

Vessel No. 3.—An urn of graceful outline, bearing a small check-stamp, found in bits and since put together, with slight restoration (Fig. 139). Two holes below the rim show where a former fracture has been held together by the aid of a cord or sinew. There is the usual hole broken through the base.

FIG. 142.—Vessel No. 13. Mound at Bristol. (Half size.)

Vessel No. 6.—This vessel, found in fragments, had a rude decoration below the neck made up of diagonal lines.

Vessel No. 8.—An interesting ceremonial vessel having red pigment inside and out, and for handle a head representing that of a turkey-buzzard (Fig. 140). Perforations surround the body of the vessel, all of which, including one through the base, were made before the clay was baked. Height of body, 6.5 inches; maximum diameter, 6.25 inches. There has been a certain amount of restoration on the body, but none unless adjacent parts clearly authorized it.

Fig. 143.—Vessel No. 14. Mound at Bristol. (About four-fifths size.)

Vessel No. 9.—A graceful, undecorated, globular bowl with a small perpendicular rim.

Vessel No. 10.—A ceremonial vessel partly covered with red pigment, 11 inches maximum diameter of body; height, 8.75 inches (Fig. 141). There are two bird-head handles, on one of which a central portion of the bill has been restored, and an entire bill, added to the other. There are two encircling rows of circular holes,

made before the clay was "fired." Curiously enough, this ready-made mortuary vessel has no basal perforation.

Vessel No. 11.—A globular bowl of thick ware, decorated on the inside with crimson pigment. The only part of the outer surface showing decoration is an upright rim about 1 inch in height.

Vessel No. 13.—A bowl of yellow ware, shown in Fig. 142. A perforation has been broken through the base.

Vessel No. 14.—Has a complicated stamp decoration around the neck (Fig. 143). The usual hole has been knocked through the bottom.

Vessel No. 16.—An ordinary shape having for decoration two incised, encir-

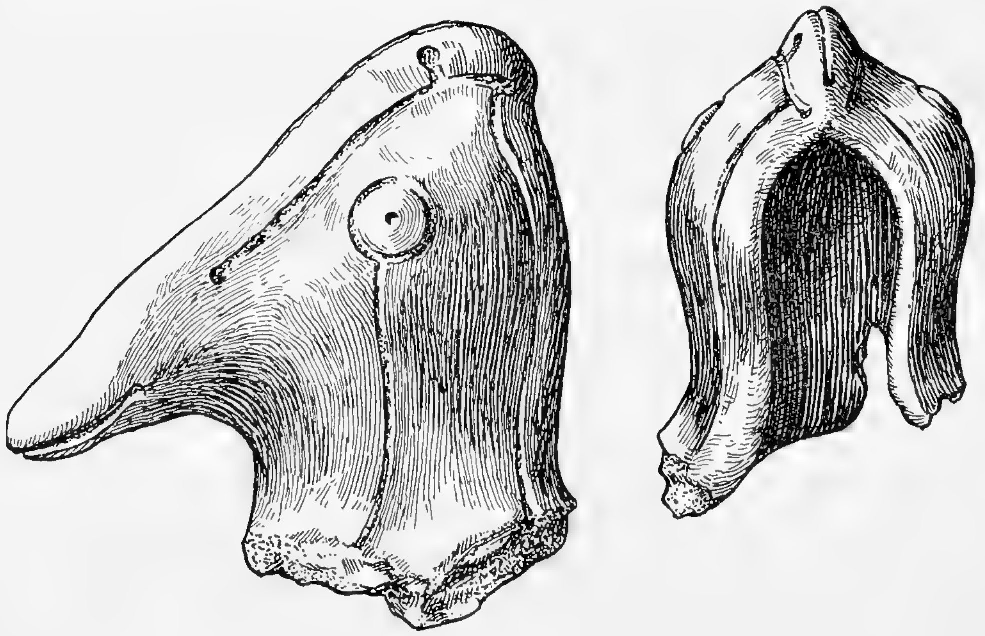


FIG. 144.—Handle of earthenware vessel. Two positions. Mound at Bristol. (Full size.)

cling lines just below the rim. This vessel, which has the ordinary basal perforation, was broken when placed in the mound, as one-half was found within the other half, in a reversed position.

Unassociated, was a bird-head handle decorated with crimson paint, having a feature not before met with by us, consisting of an opening at the back of the head. This head is shown, side view and back view, in Fig. 144.

MOUND NEAR ATKINS' LANDING, APALACHICOLA RIVER, CALHOUN COUNTY.

This mound, on the edge of the swamp, about one mile in a SE. direction from the landing, on property of Mr. W. R. Shields, living nearby, had been riddled with holes and seamed with trenches previous to our visit. Its height is 3 feet, its basal diameter, 40 feet.

Such parts of the mound as had been left intact yielded nothing to our investigation.

Mounds near Aspalaga, Apalachicola River, Gadsden County (3).

About one mile in a NE. direction from Aspalaga Landing, on high ground, is a large field, long under cultivation, property of the late Mr. John L. Smith and now under management of Mr. William Smith, living nearby. Over this field, and especially over spaces, dwelling sites, having a sprinkling of broken mussel-shells and of *Georgiana vivipara* and *Campeloma lima*, were bits of pottery, undecorated, with small check-stamp, with complicated stamp, with rude punctate decoration, and, in one or two instances, of good ware with superior, incised decoration. There were also, scattered here and there over these sites, pebbles, hammer-stones, hones, fragments and flakes, of chert, partially-made arrowheads, a few complete ones.

In this field were three mounds, all of sand, two of which, low and much spread, were shown by thorough digging to have been domiciliary in character.

The third and largest had a somewhat irregular outline caused, or, at all events, increased, by the use of the plough. As the mound stood on a gentle slope, the height of the artificial portion was hard to determine. Measurements from the west side gave an altitude of 6 feet 8 inches. On the east side, where the foot of the slope was, the mound was 9 feet 5 inches high. According to members of the family, the height of the mound had been reduced at least 5 feet by continued cultivation. East and west the basal diameter of the mound was 98 feet, and 90 feet, north and south.

While there had been a certain amount of previous digging, it was small considering the area of the mound. The mound, including certain additional territory surrounding it, was completely dug through by us.

Human remains were found at fifty-four points, mainly in the eastern and western sides, though burials extended around somewhat as the body of the mound was reached, certain ones being in the central portion. The forms of burial were: the lone skull, the bunch, the flexed burial, and bones scattered here and there. In addition to these there was, on the base of the southwestern portion of the mound, a small pocket of calcined fragments of human bones. Such deposits are met with occasionally in mounds along the northwest Florida coast.

The condition of human remains was fragmentary in the extreme, and such parts as remained were in the last stage of decay. Burial No. 29 consisted of a dark stain in the sand, and several teeth crumbling into dust. Burial No. 34 was made up of a few minute fragments of bone. Presumably, certain burials in this mound had entirely disappeared.

But one calvarium was recovered. It showed no artificial flattening.

Considering the extent of the mound, remarkably few objects had been placed with the dead.

Burial No. 2, near the surface, a skeleton from which the ribs and one arm were missing, had seven shell beads of fair size, at the neck, and a polished "celt" under the arm.

Burial No. 18 was represented by one bit of bone. With this burial was charcoal and what remained of a shell drinking-cup.

Burial No. 26, remnants of a skull, had in direct association, about one-third of a large pot.

Burial No. 28, indications of a flexed burial, had a few shell beads.

Burial No. 39, the remains of a skull, had nearby: a polished "celt;" a discoidal stone of quartzite, 3 inches in diameter on top, with sides slightly converging toward the base, and a shallow pit in the center of the upper part, rough in appearance, possibly used for the cracking of nuts; a lance-head of chert, 4.5 inches in length; two arrow-points or knives, of the same material; part of a lance-head, a flake, two irregular bits, all of chert; one smoothing pebble; one pebble-hammer; one triangular gouge of shell, with unground edge; two cutting implements wrought from columellæ; certain shells (*Murex flavescens*, *Rangia cuneata*, *Dosinia discus*).

With several burials was more or less charcoal. In one place, where bones probably had disappeared through decay, was sand tinged with hematite. Just above the base, at the center of the mound, was a local layer of red clay, on part of which lay a few scattered bones.

Unassociated objects, except earthenware, were: several pebbles; one arrowhead or knife, of chert; a thick sheet of mica, roughly rounded; another with the

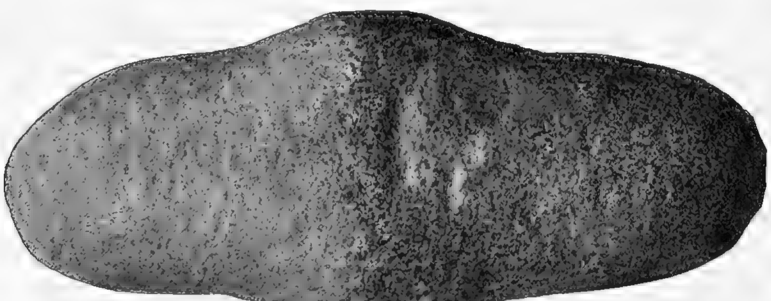


FIG. 145.—Pebble-hammer. Mound near Aspalaga. (Full size.)

outline of a spear-point; several shell drinking-cups found with the pottery deposit; a pebble-hammer of sedimentary rock, about 4 inches long, showing an encircling band at the middle, consisting of the original surface, the remainder being worked down and rounded as to the ends, one of which is somewhat chipped by use (Fig. 145).

In the eastern part of the mound, under the slope, with a sherd deposit, were a number of masses of lime-rock, each from 1 foot to 18 inches in diameter. Rock of this sort is found along the northernmost parts of the Apalachicola river, near which this mound was.

At the extreme eastern margin of the mound, the advance guard of the pottery deposit, was a number of sherds scattered here and there, some undecorated, some bearing a complicated stamp, also several bases of vessels with four feet. These sherds were followed by portions of vessels in fragments, and by vessels from which considerable parts were missing. All these were of inferior ware and decoration.

The first whole vessel, a small bowl with in-turned rim, undecorated, was met with 8 feet from the margin, somewhat north of east in the mound. This vessel was followed by single ones, mostly pots, here and there, some a little more to the eastward. Some of these were undecorated or had a faint complicated stamp; several had feet; and some, notches around the rim. Among these vessels were fragments of others, also of inferior ware, showing the ready-made basal perforation.

Still farther in were a few vessels, or large parts of vessels, all badly crushed, some of which, cemented together and restored in part, are included among vessels particularly described.

All these vessels and sherds lay in sand much darker than that of the remainder of the mound, a feature so frequently noted among the mounds of the northwest Florida coast.

The more noteworthy vessels will now be described in detail. But one is without the usual mortuary perforation.

Vessel No. 2.—Part of a vase of yellow ware, with the upper portion missing (Fig. 146).

FIG. 146.—Vessel No. 2. Mound near Aspalaga. (Full size.)

Vessel No. 4.—A diminutive pot, undecorated save for notches around the rim.

Vessel No. 5.—Certain parts of a large, globular vessel of porous, inferior ware, decorated on the outside with red pigment. The body has numerous perforations made before the "firing" of the clay. The base is missing. A large, red, bird-head handle was found with this vessel, but the parts uniting it to the vessel were not met with.

Vessel No. 7.—A vase 10.5 inches high and 8.25 inches in maximum diameter of body which is heart-shaped in longitudinal section. The neck is upright and flaring, and has incised and punctate decoration with crimson pigment in places.

The base is somewhat flattened to allow the vessel to maintain an upright position (Fig. 147).

Vessel No. 8.—A vessel of about 4 quarts' capacity, of inferior, yellow ware, found in fragments, and restored in places (Fig. 148). The interesting, incised and punctate decoration, shown diagrammatically in Fig. 149, is repeated on the opposite side of the vessel.

FIG. 147.—Vessel No. 7. Mound near Aspalaga. (Half size.)

Vessel No. 9.—Certain parts of a large human effigy-vessel were met with at different levels in the mound and often many feet distant one from another. Part of the base, some of the body, and the face, with the exception of a fragment of the lower left-hand part, were recovered and have been cemented together, with considerable restoration which, however, was clearly indicated by portions present. An interesting and novel feature is perforations in the eyes and ears (Fig. 150). A number of other vessels, broken and scattered in the way this figure was, were present in the mound.

FIG. 148.—Vessel No. 8. Mound near Aspalaga. (Three-fifths size.)

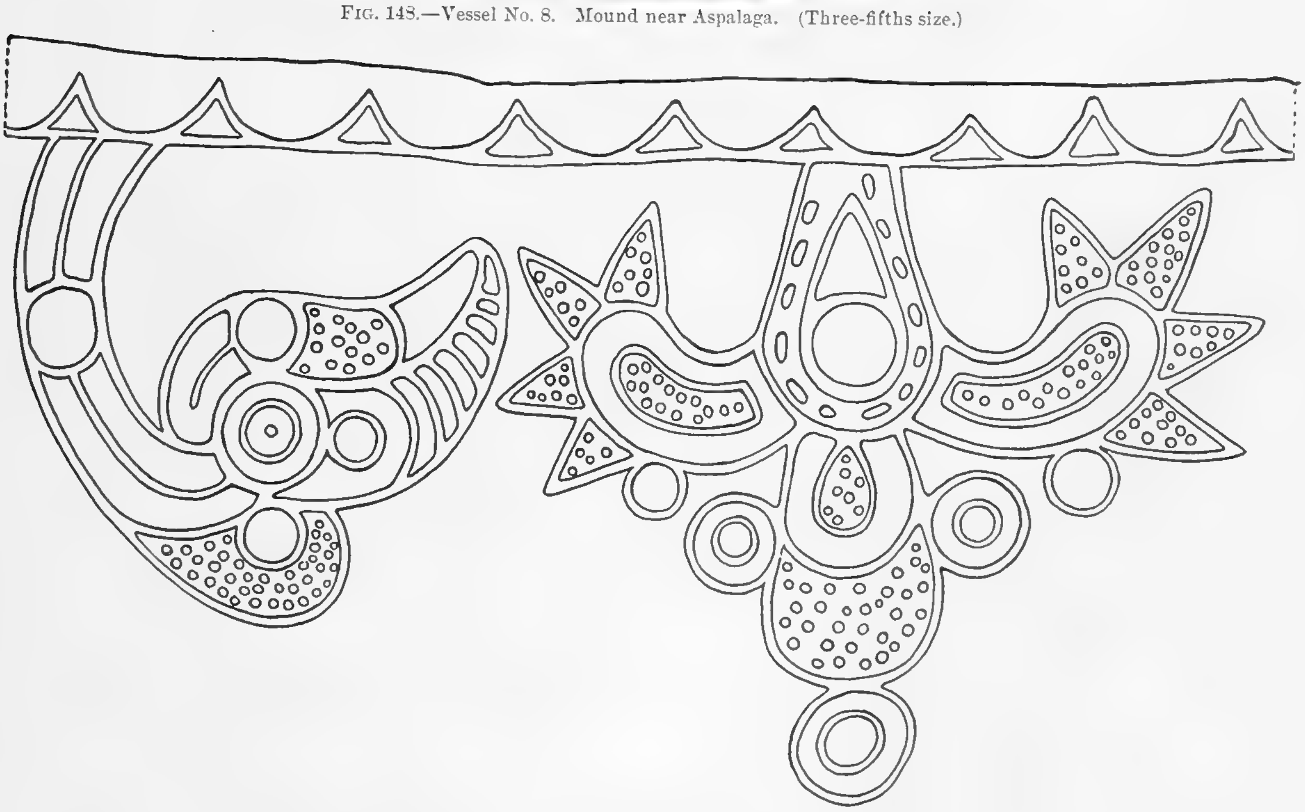


FIG. 149.—Vessel No. 8. Decoration. Mound near Aspalaga. (Two-thirds size.)

FIG. 150.—Vessel No. 9. Mound near Aspalaga. (About half size.)

Vessel No. 10.—Ovoid, with circular depressions covering the entire body, much like a vessel found by us in the smaller mound near Hare Hammock, northwest Florida coast,[1] though that vessel is more carefully made, and has, also, a narrower opening. The impressions on that vessel have a comparatively smooth sur-

[1] *Op. cit.*, Part II, Fig. 138.

face, while those on the vessel from this mound seem to owe their origin to a circular object with a slight, rough projection at the center.

Vessel No. 11.—Twenty-one feet in from the eastern margin of the mound the black sand ended and no earthenware of any sort was met with in the mound afterward, with the exception of an unassociated vessel in the southern portion, having an ovoid body with upright rim flaring, then constricted. There is a rather rough, complicated stamp-decoration. This vessel has no basal perforation (Fig. 151).

Several bird-head handles lay unassociated in the sand. One has a perforation apparently cut after the baking of the clay (Fig. 152). Another (Fig. 153), large and hollow, has red pigment around the eyes.

In Fig. 154 is given a selection of sherds from this mound. As might be expected, since the territory in which the mound was is near Georgia, the complicated stamp is largely represented. One, on the left of the second row, did not come from the mound, but from the surface nearby.

Fig. 151.—Vessel No. 11. Mound near Aspalaga. (About four-fifths size.)

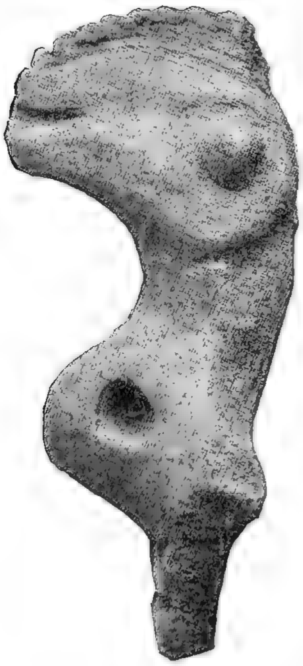


Fig. 152.—Earthenware handle of vessel. Mound near Aspalaga. (Full size.)

Fig. 153.—Earthenware handle of vessel. Mound near Aspalaga. (About full size.)

Fig. 151.—Selection of sherds. Mound near Aspalaga. (Half size.)

MOUND NEAR SAMPSON'S LANDING, APALACHICOLA RIVER, JACKSON COUNTY.

This mound, within sight of the road, about one-half mile in a W. direction from the landing, on property belonging to Mr. D. L. McKinnon, Marianna, Florida,

FIG. 155.—Vessel of earthenware. Mound near Sampson's Landing. (About four-fifths size.)

had been dug into superficially in the center, in addition to which a hole about 2.5 feet square had been sunk to the base. The mound, sand with a certain admixture of clay and gravel, had a height of 4.5 feet; a basal diameter of 45 feet. It was totally dug down by us, with the exception of parts left around two trees.

Human remains were encountered forty-seven times, the bones being badly decayed, enough only remaining to indicate the form of burial. Several calvaria, recovered uncrushed, gave no evidence of artificial flattening.

The burials, found in all parts of the mound, from the margin in, were as follows as to form: scattered bones, 1; lone skulls, 13; bunched burials, 11; flexed skeletons, 22. Of the flexed skeletons, none of which was met with until the digging approached the body of the mound, all were flexed on one side or on the other, except one which lay on the back with the knees raised. Three flexed burials lay under masses of lime-rock. One lone skull was in dark sand, with charcoal nearby.

Fig. 156.—Vessel of earthenware. Mound near Sampson's Landing. (Five-sixths size.)

There were in the mound, in addition to several pebbles, two "celts" which lay separately, unassociated, and seemed to have been put in in a general way. Near certain earthenware were mica and part of a shell drinking-cup.

Soon after the digging began a few scattered sherds were found, plain, with the small check-stamp, and with a complicated stamp. Later, part of a pot with a complicated stamp, and with a hole knocked through the base, came from the southwestern part of the mound, and a large fragment with rude, incised decoration and basal perforation lay near the southern margin.

When the digging had progressed a number of feet into the eastern side of the

mound, a number of parts of vessels, of inferior ware, as were all the vessels in this mound, bearing the small check-stamp, were encountered. Just behind these were six vessels together, one, undecorated, of rather graceful, elliptical section, with a hole knocked through the base, in common with all vessels from this mound. Four vessels of this deposit are undecorated; the sixth has a series of roughly incised, diagonal, parallel lines, around the neck which, long and flaring, rises from a globular body.

Just to one side of these was a mass of sherds from various vessels, and a little farther in, were two pots with portions missing, one having a faint complicated

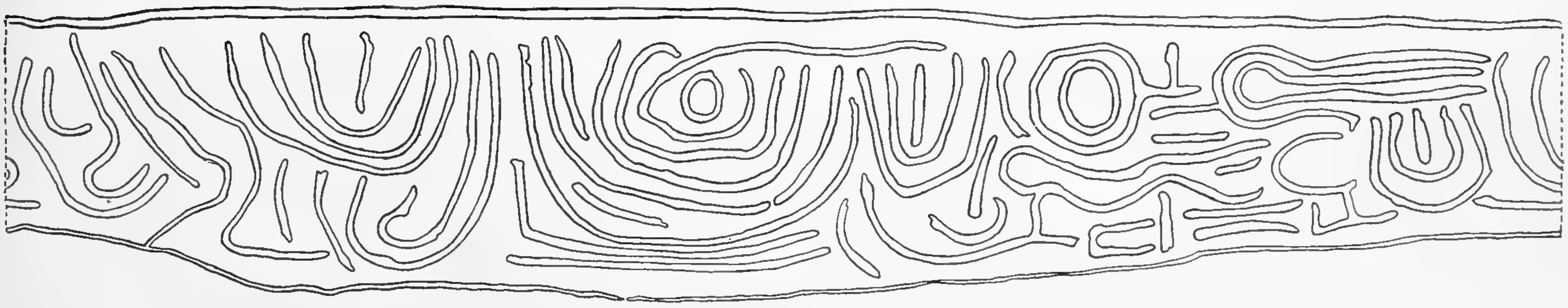


FIG. 157.—Decoration on vessel shown in Fig. 156. Mound near Sampson's Landing. (Half size.)

stamp, the other undecorated. With these was a graceful jar of about three quarts' capacity, shown in Fig. 155, having a flat, square base. Around the neck is a complicated stamp-decoration. Near this jar was a vessel in fragments, having a complicated stamp, and a rude pot also with a stamped decoration around the neck.

Somewhat farther in the same direction, well toward the center of the mound, were four pots and bowls, three broken and undecorated. The fourth vessel (Fig. 156) has a curious, incised design, evidently symbolical, shown diagrammatically in Fig. 157. Part of the rim has been restored. A few feet to one side of this vessel was a pot with parallel lines roughly incised beneath the rim.

This was the last occurrence of earthenware met with by us on the Apalachicola river, and it is interesting to note the persistence of the ceremonial deposit of earthenware in the eastern part of the mounds and the occurrence of the mortuary mutilation of the base.

Mounds near Chattahoochee Landing, Apalachicola River. Gadsden County (7).

On the river's bank, at the landing, half cut away by the wash of freshets, is part of a domiciliary mound of clay, formerly circular in outline. Height, 7 feet; diameter of base, 78 feet; diameter of summit plateau, 38 feet.

A short distance farther up, along the bank, is the wreck of a large mound half washed away by the river. This mound, of clay, has several frame buildings upon it. Its height is 11 feet.

In the swamp, in sight from the river, and but a short distance from the mounds just described, are four others. The southernmost, of circular outline, composed of sand with a certain admixture of clay, is 4 feet in height, 70 feet across the base, and 40 feet across the summit plateau.

About 50 yards farther, in a NW. by N. direction, is a circular mound of clay, covered with a considerable thickness of sand. Basal diameter, 66 feet; diameter of summit plateau, 36 feet; height, 3 feet.

Fifty yards in a NW. direction from the last mound, is a mound of circular outline, 3.5 feet high, 58 feet across the base and 26 feet across the summit plateau.

Continuing 40 yards WSW., we came upon a mound near the road, much spread, 46 feet in diameter of base, and 1.5 feet high.

The two mounds partly cut away by the river were not dug into by us, the cross-section made by the river showing them to have been domiciliary.

The swamp-mounds were thoroughly investigated and found to be domiciliary in character.

The mounds of the Apalachicola river yielded nothing especially novel.

The forms of burial were the same as those prevailing along the northwest coast of Florida, namely, the bunch, the flexed skeleton, the lone skull, scattered bones, and, very rarely, the pocket of calcined remains. The burial of skulls under great bowls, a custom met with in places along the Florida coast as far east as St. Andrew's bay, was not met with on the Apalachicola river; nor was the urn-burial proper, where bones are placed in vessels covered by others, inverted, met with by us on the river, though, last season, we found one example of this form of burial in a mound on Ocklockonee bay, to the eastward of Apalachicola.

The earthenware of the river was found to be inferior in quality. The gritty ware of Georgia was not met with nor was the shell-tempered ware of Alabama, with the exception of certain pieces in a single mound. In this mound, curiously enough, were several vessels of polished, black ware, the specialty of Mississippi, which we had not found east of Choctawhatchee bay, on the coast, and many earthenware vessels which, in material, shape and decoration, recalled the yield of mounds considerably farther to the westward.

Ceremonial vessels, "killed" by a basal perforation and by holes throughout the body, made before the firing of the clay, were found in considerable numbers along the Apalachicola river and, as is the case with similar vessels met with by us along the Florida coast between St. Andrew's bay and the Warrior river, the ware is most inferior in quality, as might be expected of vessels purposely made for interment with the dead.

The custom prevalent along the northwest Florida coast, to place deposits of vessels for the dead in common in the eastern part of mounds, obtained also on the Apalachicola river.

INDEX.

A COLLECTION OF FISHES

FROM

SUMATRA.

BY

HENRY W. FOWLER.

PHILADELPHIA:
1904.

ERRATA.

By an inadvertence the following references to plates, in the text, are incorrect. They should read:

Page 546, *Zenodon cæruleolorum.* Plate XXIV.
" 548, *Parapercis atromaculata.* Plate XXIV.
" 549, *Malacanthus urichthys.* Plate XXII.
" 551, *Gobius venustulus.* Plate XXVII.
" 552, *Scartichthys basiliscus.* Plate XXV.
" 553, *Scartichthys stigmatopterus.* Plate XXV.
" 554, *Entomacrodus leopardus.* Plate XXVII.
" 555, *Entomacrodus calurus.* Plate XXVI.
" 556, *Cynoglossus os.* Plate XXVIII.

A COLLECTION OF FISHES FROM SUMATRA.

By Henry W. Fowler.

During the late summer and autumn of 1901 Mr. Alfred C. Harrison, Jr., and Dr. H. M. Hiller formed an important zoölogical collection while pursuing their explorations in Sumatra. Most of the reports on the different groups have already appeared in the Proceedings of the Academy, and as the fishes comprise a large part of the material they have demanded corresponding attention.

But two localities appear on the labels. With the exception of a few fresh-water forms taken at Batu Sangkar, Tanah Datar, in Padangsche Bovenland, at an elevation between 1500 and 3000 feet, the specimens were secured in the markets or environs of Padang. Many are food-fishes, evidently of importance, though no particular information concerning the fisheries, local names, etc., has been preserved.

The collection was submitted to me for examination by Dr. Samuel G. Dixon, President of the Academy, to whom I am indebted for this opportunity of studying East Indian fishes. At that time I was at Stanford University, assisting Dr. Jordan with the work on his Japanese fishes, and later the United States Fish Commission with their report on the Hawaiian collections. When first examined, the colors, which had been well preserved, were noted, as the fishes had all been prepared in arrack or rice-rum. After being placed in alcohol they soon more or less faded. Through the courtesy of Dr. Jordan I had the opportunity of examining and comparing the fine collections in Stanford University. From the other well-known ichthyologists located there I also received many courtesies, especially from Dr. Oliver P. Jenkins, who freely placed his collection of Hawaiian fishes at my disposal. I am also indebted to Dr. Barton W. Evermann, for suggestions and comparisons with Hawaiian forms. Dr. Seth E. Meek has also kindly forwarded notes on his collection of Aden fishes. Finally, to the naturalists of the Academy I wish to express appreciation for many courtesies, more especially to Mr. Witmer Stone and Dr. Henry A. Pilsbry. To these gentlemen I am under many obligations. Mr. Stone has not only granted numerous and varied favors but also freely offered advice and excellent suggestions. Upon returning to Philadelphia I found it necessary to entirely revise the original manuscripts written at Stanford University, more especially as the library and museum of the Academy offers so many facilities for consultation and comparison. At present the material is contained in the Academy with the exception of a series of duplicates left in Stanford University. The latter includes several cotypes.

Difficulty, as usual, has been experienced in the identification of a number of species, owing to the short, incomplete or unsatisfactory accounts, with little relation

or attention to geographical distribution. Many forms said to range throughout the Indian and Pacific Oceans should be examined and compared by means of abundance of material before such views can be established as absolutely final. My own acquaintance with the Japanese ichthyic fauna has at least convinced me of its great difference from the East Indian, but few forms straying up in the warm southern current. So far as one may judge at present that of the Indian basin has much in common, but just what exhaustive material will indicate remains to be seen. The work of the early writers on Red Sea and East African forms still needs the most careful and scrutinizing attention, as it forms the basis of much of the work of their successors also in other regions. In some cases I have been led to renounce their decisions, due in larger part to incongruities and differences accruing in the works of the latter. Polynesia, Micronesia and Australia also indicate different faunas, though they also display considerable East Indian infusion.

In matters of nomenclature I have followed the code of the American Ornithologists' Union, with several exceptions. These have already been noticed by Drs. Jordan and Evermann. They concern the names of males having precedence over names of females when occurring on the same page, and the spelling of names. These conclusions appear to me valid. However, I do not accept the views of Dr. Jordan regarding the selection of the first species as the type of a composite genus, unless the author or first reviser has so indicated. Elimination is now so generally accepted by the majority of American naturalists that its rejection can only lead to confusion. I might also add that all names spelled differently, such as Zenodon for Xenodon, etc., are regarded as different.

HEMISCYLLIIDÆ.

1. Chiloscyllium indicum (Gmelin).

GALEORHINIDÆ.

2. Galeocerdo tigrinus Müller and Henle.
3. Carcharhinus menisorrah (Müller and Henle).

SPHYRNIDÆ.

4. Sphyrna zygæna (Linnæus).

RHINOBATIDÆ.

5. Rhynchobatus djiddensis (Forskål).

DASYATIIDÆ.

6. Tæniura lymma (Forskål).
7. Dasyatis russellii (Gray).

PLOTOSIDÆ.

8. Plotosus anguillaris (Bloch).

CHLARIIDÆ.

9. Chlarias batrachus (Linnæus).
10. Chlarias olivaceus sp. nov. Plate XXVIII, lower figure.

Clarias fuscus Valenciennes, Hist. Nat. Poiss., XV, 1840, p. 284. Sumatra. (M. Desjardins.) (Not *Macropteronotus fuscus* Lacépède).

Head $5\frac{1}{4}$; depth 7; D. 66; A. 51; P. I, 9; V. 6; width of head $1\frac{1}{8}$ in its length; depth of head 2; snout $2\frac{3}{5}$; eye 11; width of mouth $2\frac{1}{3}$; interorbital $1\frac{9}{10}$; pectoral spine $2\frac{1}{6}$; pectoral fin $1\frac{1}{2}$; ventral $2\frac{1}{2}$; caudal $1\frac{1}{2}$; least depth of caudal peduncle 3.

Body elongate.

Head broad and strongly depressed. Snout broad and flattened. Eye small, and well anterior. Mouth broad, and with rather thin papillose lips. Teeth minute, rather sharp, and in broad bands in jaws. A broad crescent-shaped patch of fine teeth on vomer with a slight projection posteriorly. Anterior nostrils in short tubes near edge of snout, but closer together than posterior. Posterior slit-like, behind bases of nasal barbels midway between anterior and front margin of eye. Interorbital space broad, flattened, and slightly elevated, especially posteriorly. Nasal barbel reaching almost opposite edge of gill-opening. Maxillary barbel not quite reaching tip of pectoral spine. Outer mental barbel reaching about first two-fifths of pectoral spine. Inner mental barbel reaching base of pectoral spine. Fontanel shaped like a plumb-bob, rounded posteriorly, and not quite equal to space between two nasal barbels. Interparietal fontanel about equal to eye.

Gill-rakers slender, moderate in number, pointed and not as long as filaments on first arch.

Skin rather smooth. Lateral line somewhat obsolete along middle of side to base of caudal.

Dorsal beginning well behind tip of depressed pectoral, and separate from caudal posteriorly. Anal similar to dorsal and inserted a little nearer tip of snout than base of caudal. Pectoral a little less than half of space to ventral. Pectoral

spine smooth on outer surface, and equal to about two-thirds length of fin. Ventral inserted well behind origin of dorsal and reaching past origin of anal. Caudal elongate and rounded. Anal papilla long.

Color in arrack dark blackish-olive above, lower surface brown. Vertical fins blackish-olive. Pectoral and ventral brownish, darker above. Indistinct traces of vertical series of pale dots on sides of back. Barbels blackish. Peritoneum whitish.

Length $11\frac{1}{4}$ inches.

Type No. 27,280, A. N. S. P. Padang.

This fish, originally described by Valenciennes, is said to have the head, measured to end of occipitial process, $4\frac{2}{3}$ in total length of body, including caudal, and fins with 67 dorsal and 48 anal rays. The Formosan fish figured by Drs. Jordan and Evermann as *Chlarias fuscus* (Lacépède) is certainly different. A comparison of the type with four cotypes with same data, and measuring $7\frac{1}{2}$ to $10\frac{1}{4}$ inches, shows dorsal ranging from 60 to 63 and anal 50 or 51 rays. It is, however, in the more slender or elongate body that *olivaceus* differs from related species. Space between occiput and dorsal was found to be $2\frac{4}{5}$, $2\frac{2}{3}$, $2\frac{1}{2}$, $2\frac{2}{3}$ and $2\frac{7}{8}$ in head, measured from former point to tip of snout. Gill-rakers 5 + 4 on first arch of one of cotypes. Possibly records for *Chlarias liacanthus* in Sumatra should go with this species.

(*Olivaceus*, olive-color.)

SILURIDÆ.

11. Netuma thalassina (Rüppell).
12. Hypselobagrus micracanthus (Bleeker).
13. Glyptothorax platypogonides (Bleeker).
14. Glyptothorax platypogon (Valenciennes).

COBITIDIDÆ.

15. Hymenophysa hymenophysa (Bleeker).

CYPRINIDÆ.

16. Schismatorhynchus hetorhynchus (Bleeker).
17. Osteochilus hasseltii (Valenciennes).
18. Osteochilus kuhli (Bleeker).
19. Labeobarbus tambra (Valenciennes).
20. Labeobarbus douronensis (Valenciennes).
21. Cyclocheilichthys siaja (Bleeker).
22. Barbodes schwanenfeldii (Bleeker).
23. Barbodes fasciatus (Bleeker).
24. Barbodes binotatus (Valenciennes).
25. Hampala macrolepidota (Valenciennes).
26. Rasbora argyrotænia (Bleeker).
27. Mystacoleucus padangensis (Bleeker).
28. Cyprinus carpio Linnæus.

MONOPTERIDÆ.

29. Monopterus albus (Zuiew).

ANGUILLIDÆ.

30. Anguilla bengalensis (Gray).
31. Anguilla bicolor McClelland.

OPHICHTHYIDÆ.

32. Cirrhimuræna chinensis Kaup.

MURÆNIDÆ.

33. Evenchelys macrurus (Bleeker).
34. Gymnothorax fimbriatus (Bennett).
35. Gymnothorax flavimarginatus (Rüppell).

CHIROCENTRIDÆ.

36. Chirocentrus dorab (Forskål).

CLUPEIDÆ.

37. Sardinella brachysoma (Bleeker).
38. Ilisha hoevenii (Bleeker).
39. Ilisha brachysoma (Bleeker).
40. Opisthopterus macrognathus (Bleeker).

DUSSUMIERIDÆ.

41. Dussumieria elopsoides Bleeker.

ENGRAULIDIDÆ.

42. Anchovia commersonnii (Lacépède).
43. Anchovia encrasicholoides (Bleeker).
44. Anchovia valenciennesi (Bleeker).

SYNODONTIDÆ.

45. Saurida tumbil (Bloch).
46. Harpodon nehereus (Hamilton).

MACROGNATHIDÆ.

47. Mastacembelus unicolor Valenciennes. Plate VIII, upper figure.

BELONIDÆ.

48. Tylosurus leiurus (Bleeker).
49. Tylosurus melanotus (Bleeker).
50. Tylosurus crocodilus (Lesueur). Plate IX, upper figure.

HEMIRAMPHIDÆ.

51. Hyporhamphus neglectus (Bleeker).
52. Hemiramphus far (Forskål).

PEGASIDÆ.

53. Parapegasus natans (Linnæus). Plate VII, two figures above to right.

SYNGNATHIDÆ.

54. Hippocampus tæniops sp. nov. Plate VII, upper figure to left.

Head $1\frac{1}{4}$ in trunk, measured to gill-opening; depth of trunk $2\frac{1}{3}$ in its length; width of trunk $3\frac{3}{4}$; trunk $1\frac{2}{3}$ in tail; D. 18; A. 4; P. 16; rings $11+37$; depth of head, at coronet, $1\frac{5}{6}$ in its length; width of head $2\frac{3}{4}$; snout $2\frac{1}{10}$; eye 7; base of dorsal $2\frac{3}{4}$; interorbital space 2 in eye.

Body rather deep, trunk short and compressed. Tail tapering, quadrangular, with rather slender point.

Head rather deep and compressed. Snout long, of about even depth. Eye small, a trifle posterior in head. Mouth terminal, small, superior, and with rather thin jaws slightly protruding above and below. Nostrils small, close to middle

of front rim of orbit. Interorbital space narrow, triangular, angle forming a little in front of eyes.

Gill-opening small, lateral, opening upward, high and close to nape near nuchal keel. Coronet high, its upper surface concave, with two lateral and one posterior tubercles, and also an elevated prominence springing from ridge in front. Below latter, on each side of head, a round tubercle. Interorbital space with each side of triangle continued as bony ridges till over middle of eye, where they each form a round supraorbital tubercle. Shoulder girdle with three large round tubercles. Bones on side of head, especially opercles, with fine radiating striæ. Rings with concave surfaces, without spines, and with few rounded tubercles, best developed on ridges of first ring, lower lateral ridges of trunk, and first four or five of tail. None distinctly enlarged at regular intervals.

Fins small, with simple rays. Dorsal rather low, beginning on middle of tenth ring and then extending on to second caudal ring near its posterior margin. Anal small, short, on first caudal ring. Pectoral with a broad base, rays rather short.

Color in arrack dark brown, more or less indistinctly mottled with paler. About five deep brown oblique cross-bars on side of snout. Several oblique deep brown cross-bars on side of head. A deep almost blackish-brown band along median compartment of spaces on side of trunk from base of pectoral to tail. Body marked everywhere with numerous minute whitish dots. Fins pale, their bases dark, especially that of dorsal.

Length, measured from top of coronet to tip of extended tail, $5\frac{1}{2}$ inches.

Type No. 27,409, A. N. S. P. Padang.

One example. This species is close to *Hippocampus kuda* Bleeker,[1] which has also been recorded from Priaman and Sibogha,[2] and with which it may prove identical. However, it has one more dorsal ray, and the color is entirely different from that given in the original description. My example also has more caudal rings. The Japanese example placed by Messrs. Jordan and Snyder[3] with *H. kuda* may still be different. It differs from my specimen in such points as its agrees with Bleeker's, though its coloration is different from either. *Hippocampus kamphylotrachelos* Bleeker[4] is the only other species known from Sumatra. It differs in having twenty dorsal rays.

(Ταινία, band; ὤψ, face.)

MUGILIDÆ.

55. Liza cæruleomaculata (Lacépède). Plate XI, upper figure.

SPHYRÆNIDÆ.

56. Sphyræna toxeuma sp. nov. Plate IX, middle figure.

Head $3\frac{1}{6}$; depth $7\frac{1}{3}$; D. V—I, 9; A. II, 8; P. II, 12; V. I, 5; scales to base of caudal in lateral line about 110 (squamation injured); 12? scales between origin

[1] Nat. Tijds. Ned. Ind., III, 1852, p. 82. Singapore, in mari.
[2] Act. Soc. Sci. Ind. Neerl. (Zesd. Bijd. Visch. Sumatra), III, 1857, p. 30.
[3] Proc. U. S. Nat. Mus., XXIV, 1901, p. 15. Ishigaki, Yaeyama Island, Riukiu.
[4] Nat. Tijds. Ned. Ind., VII, 1854, p. 107. Priaman, in mari.

of second dorsal and lateral line; about 15 scales between latter and origin of anal; width of head 3 in its length; depth of head $2\frac{7}{8}$; mandible $1\frac{4}{7}$; length of depressed spinous dorsal 3; of depressed soft dorsal $2\frac{1}{4}$; of depressed anal $2\frac{4}{7}$; least depth of caudal peduncle $4\frac{2}{5}$; pectoral $2\frac{7}{8}$; ventral $3\frac{5}{6}$; snout $2\frac{1}{8}$ in head, from its tip; eye $4\frac{2}{3}$; maxillary $2\frac{1}{6}$; interorbital space $4\frac{1}{3}$.

Body elongate, rather slender, though thicker anteriorly and more compressed posteriorly. Greatest depth about origins of soft dorsal and anal. Caudal peduncle long, compressed, its depth about three in its length.

Head long, attenuate in front, flattened above, and sides compressed, especially below, so that lower surface is constricted. Snout long, pointed, its upper profile nearly horizontal and premaxillary projecting beyond its tip. Eye large, high, posterior margin a little behind last third in space between tip of snout and gill-opening. Mouth large, a little inclined, and gape reaching about two-thirds of distance to front rim of orbit. Maxillary slightly curved, expanded distally till equal to pupil, and its posterior tip not reaching, but approaching close to front rim of orbit. Expanded portion of maxillary forms rather long blunt projection above which fits into a corresponding deep obtuse preorbital groove. Jaws large, powerful, and mouth not capable of being completely closed. Mandible large, powerful, produced well beyond upper jaw, and with symphyseal protuberance. Four large compressed and slightly curved sharp teeth in front of upper jaw. Teeth uniserial along edges of upper jaw, small, and sharp. Single large canine at symphysis of mandible directed backward. Teeth along sides of mandible uniserial, compressed, sharp, at first small, then gradually increasing in size backward. About six large compressed wedge-shaped sharp pointed teeth in each palatine series, last two or three small. Tongue elongate, rounded in front, free for a good part of its length, and joined to floor of mouth posteriorly by rather thin frenum. Its surface finely asperous above. Nostrils small, inconspicuous, vertical slit near front of eye or just a little behind obtuse maxillary angle. Interorbital space flattened, a trifle elevated, slightly concave in middle, and two long low ridges running out toward end of snout. Preopercle obtusely rounded. Opercle with broad obtuse point above.

Gill-opening large, carried forward till about opposite front rim of orbit at least. Pseudobranchiæ about equal to one-third of eye.

Scales small, cycloid, and more or less deciduous in spirits. Small scales on basal portions of most of fins and extending out on a good portion of unpaired ones. Scales on back before dorsals small. Posterior half of head, including cheeks all more or less scaled. Lower margin of opercle bare. Pectorals and ventrals scaleless, and without flaps. Lateral line nearly straight to base of caudal.

Spinous dorsal small, depressable in a groove, its insertion a little nearer front margin of eye than insertion of second dorsal. Spines pungent, rather thin, second longest and close to first. Soft dorsal inserted about midway between insertion of first dorsal and base of caudal, its margin concave, first and last rays longest, and former longer than latter. Anal inserted a trifle behind soft dorsal, spines weak, first ray longest, margin concave, and last ray three-fifths its length. Caudal deeply

forked, lobes sharp pointed. Pectoral small, reaching about two-fifths length of ventral. Ventral reaching about one-fourth of distance to origin of anal.

Color faded in alcohol, pale or dull brown above, and with many narrow inconspicuous dark brown longitudinal bands arranged close together, formed by a dark tint on each scale. Spinous dorsal dark gray, becoming dusky above. Soft dorsal with its upper portion dusky. Caudal grayish. Pectoral pale, base dusky, and other fins whitish. Lower surface of body silvery-white. Peritoneum silvery.

Length $11\frac{1}{8}$ inches.

Type No. 27,470, A. N. S. P. Padang.

One example. This species originally described from Batavia by Bleeker was referred to *Sphyræna forsteri* Cuvier with doubt,[1] and other examples were subsequently also referred to it from other islands in the East Indies.[2] Dr. Günther figures a fish certainly referable to *S. forsteri*, from Tahiti, which does not agree with my example.[3] It shows 126 scales in the lateral line, and the eye is about $3\frac{2}{5}$ in the snout. Furthermore his description gives 90 scales for the lateral line, and if not an error is certainly a different species. *Sphyræna toxeuma* has 115 scales in the lateral line, counting the few on base of caudal, and the eye is hardly over 2 in snout. Dr. Günther also describes a fish from Calcutta which may be identical.[4]

(Τόξευμα, arrow.)

HOLOCENTHRIDÆ.

57. Myripristis murdjan (Forskål).

HOLOCENTHRUS Scopoli.

Holocenthrus Gronow, in Scopoli, Introd. Hist. Nat. Genera, 1777, p. 449 (*rostratus* = *adscensionis?*). (Based on *Holocentrus maxilla inferiore longiore*, etc., Gronow, Zoophylacii, 1763, p. 65, plate 4, fig. 3. Surinami = *Holocentrus rostratus* Gray, Cat. Brit. Mus. Fish., Gron., 1854, p. 173.)

58. Holocenthrus aureoruber sp. nov. Plate X, upper figure.

Head 3; depth 3; D. XI, I, 12; A. IV, 9; P. I, 12; V. I, 7; scales to base of caudal 33, and 3 more on latter; 3 scales between origin of dorsal and lateral line, and 7 obliquely between latter and origin of anal; 7 scales before spinous dorsal; width of head 2 in its length; depth of head $1\frac{1}{6}$; snout $4\frac{1}{5}$; eye 3; maxillary $2\frac{4}{7}$; mandible $2\frac{1}{5}$; interorbital space $4\frac{1}{8}$; preopercular spine $3\frac{1}{2}$; first dorsal spine $3\frac{1}{6}$; second $2\frac{1}{10}$; third $1\frac{5}{6}$; fourth $1\frac{3}{4}$; last 5; third developed dorsal ray $1\frac{4}{5}$; third anal spine $1\frac{1}{2}$; fourth $2\frac{1}{4}$; second anal ray $1\frac{5}{6}$; upper caudal lobe $1\frac{1}{2}$; least depth of caudal peduncle $3\frac{3}{4}$; pectoral $1\frac{7}{12}$; ventral $1\frac{5}{12}$; ventral spine 2.

Body elongate, oblong, compressed, back elevated, convex, and lower profile nearly straight. Greatest depth about base of pectoral. Caudal peduncle small, compressed, its least depth about one and two-thirds in its length.

Head moderate, rather deep, compressed, and upper profile convex. Snout

[1] Nat. Tijds. Ned. Ind., VII, 1854, p. 424.

[2] L. c., IX, 1855, p. 285. Manado.——Act. Soc. Sci. Ind. Neerl. (Besch. Visch. Amb.), I, 1856, p. 4. Amboina.——Nat. Tijds. Ned. Ind., XII, 1856, p. 293. Bali.——L. c., XII, 1857, p. 371. Sangir-eilanden.

[3] Journ. Mus. Godef. (Fische der Südsee), XI, 1877, p. 211, plate 119, fig. a.

[4] Cat. Fish. Brit. Mus., II, 1860, p. 337.

steep, blunt, rather broad, and short. Eye large, anterior, its upper margin impinging on upper profile. Mouth low, slightly inclined, and gape reaching opposite front rim of orbit. Jaws protruding, upper little beyond lower and tip of snout, which is concave. Maxillary broad distally till equal to two and a quarter in eye and reaching for three-fifths its diameter. Lips thick and fleshy, especially along sides. Teeth fine, minute, and in broad bands in jaws. Minute teeth in patches on palatines and vomer. Tongue long, pointed and free in front. Nostril a large vertical slit, close to and in front of lower rim of orbit. Interorbital space broad, concave, and with two broad low median longitudinal ridges. Bones of head all more or less striate, and with serrated edges. A strong spine directed outward on each side of snout, and another below each nostril. Margin of infraorbital strongly dentate. Three broad infraocular spines running forward till just behind nostril. Opercle with two flat spines, upper longer. Preopercle with a long dagger-like spine reaching opposite base of first developed pectoral ray. Serrations along margin of preopercle a little larger below. No nasal spines.

Gill-opening extending forward till opposite middle of eye. Gill-rakers 6 + 10, counting rudiments, short, compressed, and sometimes clavate. Pseudobranchiæ large, and about equal to pupil. Gill-filaments shorter, though only a little longer than rakers.

Scales large, finely ctenoid, and rather narrowly imbricated. Scales along bases of dorsals and anal spinescent, those of latter fin elongate and pointed. Greater portion of caudal covered with small scales, margins naked. Base of pectoral with small scales. No pectoral flap, and ventral with a sharp pointed scale at its base. Lateral line concurrent with base of dorsal and running down along upper side of caudal peduncle to middle of base of caudal. Opercle with a single row of large scales, and five rows on cheek, head otherwise naked.

Origin of spinous dorsal a trifle in front of that of pectoral, spines alternately enlarged, forming a double row, and depressable in a groove. Fourth longest, and others graduated posteriorly to last, which is shortest. Membranes of spines deeply incised along their margins. First few anterior dorsal rays longest, and margin of fin slightly convex at this point. Origin of soft dorsal about opposite that of spinous anal. Third anal spine large, broad, reaching near tip of first anal rays. Fourth anal spine shorter and slender. Origin of soft anal falling about under middle of soft dorsal's base, and its margin slightly convex. Caudal small, forked, and lobes with rather broad points. Pectoral elongate and pointed. Ventral inserted a little behind pectoral and reaching about three-fifths of distance to caudal. Ventral spine elongate, slender, and straight.

Color in arrack pale golden, with about nine rather narrow deep rosy longitudinal bands along sides. Fins more or less pale or whitish, washed or tinted with pale orange. Ventrals pale rosy-white. Each scale on cheek with a deep rosy blotch. Abdomen whitish. Most of scales on back minutely punctuated with brown, and below soft dorsal a large dusky-brown blotch. A pale brown blotch at base of upper caudal rays and traces of another at bases of posterior anal

rays. Base of pectoral inside fin lemon-yellow. Edges of membranes between dorsal spines lemon-yellow. Inside of gill-opening tinted with deep rosy. Peritoneum silvery.

Length $9\frac{1}{8}$ inches.

Type No. 27,472, A. N. S. P. Padang.

One example. This species is closely related to *Holocenthrus albo-ruber*, differing in its more elongate body. It also resembles *Holocenthrus melanospilos* (Bleeker),[1] but differs from that species in the absence of the nasal spines. Anterior or upper rays of the soft vertical fins are not dark.

(*Aureus*, golden; *ruber*, red.)

59. HOLOCENTHRUS ALBO-RUBER (Lacépède).

SCOMBRIDÆ.

60. SCOMBER KANAGURTA Rüppell. Plate XII, upper figure.
61. GERMO GERMON (Lacépède). Plate VIII, lower figure.
62. SCOMBEROMORUS GUTTATUS (Schneider).

TRICHIURIDÆ.

63. TRICHIURUS HAUMELA (Forskål). Plate VII, lower figure.

CARANGIDÆ.

64. SCOMBEROIDES TOLOO (Cuvier).
65. SCOMBEROIDES TOL (Cuvier).
66. MEGALASPIS ROTTLERI (Bloch).
67. SERIOLA CRETATA sp. nov. Plate XI, lower figure.

Head $3\frac{2}{5}$; depth $3\frac{4}{5}$; D. V—II, 32; A. I—II, 16; P. II, 17; V. I, 5; scales about 156 to base of caudal; width of head $1\frac{4}{5}$ in its length; depth of head $1\frac{1}{4}$; mandible $1\frac{9}{10}$; third dorsal spine $4\frac{3}{5}$; first developed dorsal ray $1\frac{3}{4}$; last $3\frac{3}{5}$; first anal ray $2\frac{4}{5}$; last 4; least depth of caudal peduncle $5\frac{3}{4}$; pectoral $1\frac{2}{3}$; ventral $1\frac{2}{5}$; snout $3\frac{1}{6}$, from tip of upper jaw; eye $4\frac{1}{10}$; maxillary $2\frac{1}{6}$; interorbital space $2\frac{11}{12}$; base of soft dorsal $2\frac{2}{7}$ in body; base of anal $5\frac{1}{4}$.

Body oblong, compressed, and greatest depth about opposite origin of soft dorsal. Caudal peduncle small, broad, flattened above and below, with a pit at origin of each lobe. Least depth a little less than least width.

Head deep, compressed, upper profile evenly and more convex than lower. Snout blunt, broad, convex, and with upper jaw projecting. Eye moderate, posterior margin of pupil midway between tip of mandible and gill-opening. Eyelid narrow. Mouth large, slightly inclined and curved, and mandible projecting beyond upper jaw. Maxillary moves in a rounded depression, slips under greater part of narrow preorbital, and reaches opposite middle of eye. Preorbital not quite as wide as distal expanded extremity of maxillary, which is about two and one-quarter in orbit. Teeth small, sharp pointed, and in rather broad bands in jaws. Vomer and palatines with patches of smaller pointed teeth. Tongue broad, short, blunt, a little free in front, and with two patches of minute teeth. Lower lip rather thin.

[1] Act. Soc. Sci. Ind. Neerl. (Neg. Bijd. Visch. Amb.), III, 1857, p. 2. Amboina in mari. (M. D. S. Holdt.)

Nostrils adjoining, a trifle above middle of eye, and nearer its front margin than tip of snout. Interorbital space broad, convexly elevated, and like top of head with a median trenchant keel running to spinous dorsal. Anterior part of opercle with vertical striæ. Space just above opercle, and upper part of shoulder girdle also striate.

Gill-opening large, running forward before nostrils a short distance. Gill-rakers in form of 5 blunt processes on ceratobranchial. Isthmus narrow, with a median groove. Gill-filaments about equal to three-quarters of eye, and pseudobranchiæ about four-fifths their length.

Scales small, cycloid, irregular, and extending on base of caudal and basal portion of anterior soft dorsal and anal. Small scales on upper part of head and cheeks, rest of head naked. Lateral line concurrent with back at first, then running along side of caudal peduncle, where it forms a slight keel, to base of caudal.

Spinous dorsal small, low, with pungent spines, third longest, and all depressable in a groove. Insertion of spinous dorsal a little behind origin of pectoral. Soft dorsal long, high, first developed ray longest, those comprising about first third of fin also elongate and graduated posteriorly. Last dorsal ray much longer than those immediately preceding. Origin of soft dorsal a little nearer tip of mandible than base of its last ray. Anal spine rudimentary. Anal similar to dorsal, short, anterior rays elevated, and last produced. Origin of anal a little nearer origin of soft dorsal than base of caudal. Caudal deeply forked, lobes pointed, and upper longer. Pectoral small, pointed, much shorter than ventral, and reaching a little beyond origin of soft dorsal. Ventral long, somewhat falcate, pointed, inner rays strong, and with a deep cavity at base posteriorly. When depressed fin reaches three-fifths of distance to origin of anal. Anus near last third of space between tips of ventrals and origin of soft anal.

Color in arrack dull brown, darker on back or upper surface, and belly or lower surface more or less soiled silvery. Fins dusky-brown, especially about their edges, and median portions of soft dorsal, caudal and pectoral more brownish-olivaceous. Anal pale. Ventral chalky-white. Spinous dorsal dark or deeper dusky than color of other fins. Peritoneum pale.

Length 12 inches.

Type No. 27,499, A. N. S. P. Padang.

One example. It differs from *Seriola purpurascens* Schlegel,[1] in the fin radii, longer ventral, larger eye, more convex upper profile of head, and posterior insertion of anal. Schlegel's figure shows eye nearly one-seventh of head, ventral small, and origin of anal well anterior.

(*Cretata*, chalked or whited.)

68. Elagatis bipinnulatus (Quoy and Gaimard).
69. Alepes melanoptera Swainson.
70. Alepes glabra sp. nov. Plate XII, lower figure.

Head $3\frac{3}{4}$; depth $2\frac{9}{10}$; D. I, VIII—I, 26; A. II—I, 22; P. II, 20; V. I, 5; scales 44 in curved portion of lateral line, remaining straight portion with 62 scutes;

[1] Fauna Japonica, Poiss., 1845, p. 113, plate 51. Les mers du Japon.

about 13 scales between spinous dorsal and upper part of lateral line, and nearly 48 between latter point obliquely and origin of spinous anal; width of head 2 in its length; depth of head $1\frac{1}{10}$; mandible $2\frac{1}{3}$; fourth dorsal spine $2\frac{4}{5}$; first dorsal ray $2\frac{1}{2}$; first anal ray $2\frac{1}{3}$; least depth of caudal peduncle $5\frac{1}{2}$; ventral $2\frac{2}{5}$; snout 4 in head, from its tip; eye $3\frac{4}{5}$; maxillary $3\frac{1}{6}$; interorbital space $3\frac{1}{8}$; upper caudal lobe $2\frac{7}{8}$ in body; pectoral $3\frac{1}{5}$.

Body elongate, ellipsoid, compressed, upper and lower profiles nearly evenly convex. Greatest depth at origin of soft dorsal. Caudal peduncle long, its least depth one and a third in its exposed length, and its width one and a half.

Head rather small, compressed, and obtuse in front. Snout short, convex above, and blunt in front. Eye large, well anterior, and adipose eyelid broad, nearly covering posterior half of eye. Mouth inclined, rather small, and with upper jaw projecting beyond snout. Teeth fine, crowded, and in a single series along edges of jaws. No vomerine or palatine teeth. Lips rather thin. Tongue rather long, rounded, and free in front. Mandible slightly projecting. Maxillary narrow, reaching below front margin of eye, and its distal expanded extremity about three and one-half in eye. Nostrils small, adjoining, lateral, and nearer front of eye than tip of snout. Interorbital space broad, elevated, and with a trenchant keel beginning in front and extending to origin of dorsal.

Gill-opening large, running forward a little in front of nostrils. Gill-rakers $7 + 21$, compressed, pointed, and longest equal half of eye. Filaments a little longer than longest rakers. Pseudobranchiæ small. Isthmus broad and with a groove.

Scales small, cycloid, and imbricated. Breast densely scaled. Head, except infraorbital region, opercle, and upper posterior side, naked. Lateral line abruptly arched at first till at least a little over straight portion which begins opposite origin of soft dorsal. Scutes small, deepest about nine in greatest depth of body.

Origin of spinous dorsal about over first fourth of pectoral, spines weak, depressable in a groove, and fourth longest. Origin of soft dorsal nearly midway between tip of snout and base of caudal, anterior rays elevated but not forming a lobe. Anal spines small, first inserted a little before soft dorsal, about equal in size, and depressable in a groove. Origin of soft anal a little nearer base of caudal than tip of snout, or a little behind that of soft dorsal, fin similar. Caudal deeply forked, lobes long and pointed, and upper longer. Pectoral long, falcate, reaching half way to base of last anal ray. Ventral small, inserted below origin of pectoral, reaching a little more than half way to origin of spinous anal. Anus well before anal at tip of ventrals.

Color in arrack slaty-gray above, lower sides and under surface silvery-white. A large grayish blotch on opercle. Snout and upper surface of head somewhat tinted with brown. Dorsals and caudal gray, spinous dorsal and inner margins of caudal dusky. Soft dorsal and anal with a grayish longitudinal band, median on first rays, and then submarginal. Pectoral pale grayish. Ventral whitish. Peritoneum silvery.

Length $8\frac{1}{2}$ inches.

Type No. 27,502, A. N. S. P. Padang.

One example, which resembles *Caranx macrurus* (Bleeker), *C. djedaba* (Forskål), and *C. malam* (Bleeker). These are all grouped among the species of *Selar* apparently on account of the presence of palatine, vomerine, and lingual teeth. It is not possible to determine the width of the maxillary from the descriptions given.

(*Glabra*, smooth.)

RASTRUM subgen. nov.
Type *Alepes scitula* sp. nov.

Scales rather large. Vomerine teeth in a small patch. Maxillary about a third of orbit, in this apparently different from *Alepes*.

(*Rastrum*, a rake or harrow, with reference to the vomerine teeth.)

71. ALEPES SCITULA sp. nov. Plate X, lower figure.

Head $3\frac{3}{4}$; depth $2\frac{4}{5}$; D. VIII—1, 24; A. II—I, 20; P. II, 20; V. I, 5; scales 32 in curved portion of lateral line, remaining straight portion with 45 scutes; about 10 scales between origin of spinous dorsal and upper curve of lateral line; width of head $2\frac{1}{6}$ in its length; depth of head $1\frac{1}{8}$; mandible $2\frac{1}{4}$; third dorsal spine $2\frac{1}{4}$; second dorsal ray 2; second anal ray $2\frac{1}{3}$; least depth of caudal peduncle $5\frac{1}{2}$; snout $2\frac{2}{3}$ in head, from its tip; eye $3\frac{2}{5}$; maxillary $2\frac{3}{4}$; interorbital space $3\frac{1}{8}$.

Body moderately long, compressed, fusiform, and anterior profiles evenly convex. Greatest depth at origin of soft dorsal. Caudal peduncle long, its depth nearly two in its length, and its width one and one-half.

Head rather small, compressed, rhomboid, and rather blunt anteriorly. Snout short, convex, and with upper jaw projecting. Eye small, anterior, and with a broad posterior adipose eyelid. Mouth oblique, mandible projecting beyond upper jaw, and maxillary slipping below preorbital for a good portion of its length. Maxillary expanded distally till equal to two-fifths of orbit, and reaching posteriorly nearly opposite front margin of pupil. Lips thin. Teeth minute, crowded, and uniserial in jaws. Vomer with a small patch of teeth, but palatines smooth. Tongue small, elongate, free and rounded in front, its upper surface with a few small asperities. Nostrils small, high, close together, and much nearer front rim of orbit than tip of snout. Preorbital broad, and with several radiating flutings from above. Interorbital space broad, and with a median keel which begins over nostrils and extends up to spinous dorsal. Margin of preopercle strongly convex.

Gill-opening deep, running forward below nostrils. Gill-rakers 12 + 30, long, slender, compressed, and about equal to gill-filaments, or about two-thirds of eye-diameter. Pseudobranchiæ small. Isthmus narrow, broadening posteriorly, and not trenchant.

Scales rather large, cycloid, and imbricated. Spinous dorsal with a low narrow basal sheath. Soft dorsal and anal with a rather broad basal sheath along anterior basal half of fins at least. Base of caudal with small scales, but lobes without basal keels. Upper side of head, opercle, and cheek, covered with small scales, rest of head naked. Lateral line strongly arched at first, then running

straight to base of caudal peduncle. Scutes narrow, deepest six and one-half in greatest depth of body.

Dorsal spines pungent, third longest, depressable in a groove, and insertion of fin about over first sixth of pectoral. Soft dorsal inserted nearer tip of mandible than base of caudal, anterior rays elevated. Anal similar, inserted a little nearer front rim of orbit than base of caudal, and its last ray, like that of dorsal, longer than short rays immediately preceding. Anal spines depressable in a groove, second a little over twice length of first, which is inserted about opposite origin of soft dorsal. Pectoral long, falcate, reaching well past anterior elevated dorsal rays, and about three and one-third in body. Ventral small, inserted below origin of pectoral, and reaching about half way to origin of spinous anal. Anus near tip of ventral. Abdomen with a bony trenchant keel a short distance before anal spines.

Color in arrack slaty-gray above, lower surface white and more or less silvery. Back shot with deep iridescent-blue. A black blotch a little smaller than eye, on opercle. Spinous dorsal tinged with dusky. Soft dorsal and caudal grayish, other fins pale whitish. Peritoneum silvery.

Length $5\frac{3}{4}$ inches.

Type No. 27,503, A. N. S. P. Padang.

One example. This species is close to *Caranx kuhlii* (Bleeker),[1] but from the description of that species it is impossible to determine their identity. From the definition of *Selar*, according to Bleeker, it would also have palatine teeth.

(*Scitula*, pretty neat, trim.)

72. Caranx megalaspis (Bleeker). Plate XIII, upper figure.
73. Caranx mate Valenciennes. Plate XIII, lower figure.
74. Caranx semisomnus sp. nov. Plate XVI, upper figure.

Caranx forsteri Bleeker, Verh. Bat. Genoot. (Bijd. Makreel. Vissch. Soend. Moluk. Arch.), XXIV, 1852, p. 57. Batavia, in mari—et Padang, Sumatrae occidentalis, in mari. (Not of Valenciennes.)

Head 3; depth $2\frac{2}{3}$; D. VIII—I, 21; A. II—I, 17; P. II, 18; V. I, 5; scales 46 in curved portion of lateral line, and about 38 scutes in remaining straight portion; about 23 scales between origin of spinous dorsal and upper portion of lateral line; width of head 2 in its length; depth of head $1\frac{1}{20}$; mandible 2; third dorsal spine $2\frac{1}{2}$; first dorsal ray $1\frac{7}{8}$; first anal ray $1\frac{9}{10}$; least depth of caudal peduncle $7\frac{2}{3}$; ventral $2\frac{3}{5}$; snout $3\frac{4}{5}$ in head, measured from its tip; eye $3\frac{2}{3}$; maxillary $2\frac{1}{20}$; interorbital space $3\frac{4}{5}$; pectoral $2\frac{3}{4}$ in body.

Body oblong, compressed, deep, upper anterior profile much more convex than lower, and greatest depth about origin of soft dorsal. Caudal peduncle broad, depressed, its least depth a trifle less, and its width one and one-quarter in its length.

Head deep, upper profile strongly convex. Snout steep, oblique, blunt, and with upper jaw projecting slightly beyond. Eye large, well anterior, and with a broad adipose eyelid covering nearly all of its posterior half. Mouth large, low, slightly inclined and curved, gape reaching nearly opposite front rim of pupil, and mandible projecting a little beyond upper jaw. Maxillary long, its distal expanded

[1] Verh. Bat. Genoot. (Bijd. Makreel. Vissch. Soend. Moluk. Arch.), XXIV, 1852, p. 54. Kammal Tandjong (Maduræ insulæ), in mari.

extremity free from preorbital a short distance, and equal in width to three-fifths of eye-diameter. Lips rather thick. Teeth in upper jaw biserial, conic, rather large, numerous, outer series enlarged, and also much larger anteriorly. Teeth in mandible uniserial, similar to those in upper jaw, and with a pair of canines on each side in front. Vomer, palatines, and tongue with minute teeth. Tongue rather broad, rounded and free in front. Nostrils two vertical slits, opposite middle and close to front of eye. Preorbital broad, about equal to exposed portion of eye. Interorbital space broad, elevated, and giving place to median trenchant keel which begins over nostrils and runs to spinous dorsal. A supraocular keel running up on upper side of head and another more posterior running toward shoulder not so pronounced.

Gill-opening broad, extending forward a little beyond front rim of orbit. Rakers IV, 3 + 13, III, long, compressed, slender, attenuate, and longest about two-thirds of orbit. Gill-filaments shorter. Pseudobranchiæ but little shorter than filaments. Isthmus rather narrow, and with a rather broad groove.

Scales small, more or less crowded anteriorly, and narrowly imbricated. Head, with exception of opercle above, upper posterior side, and entire cheek, naked. Scales on cheek, like those on breast, small. Narrow scaly sheath at base of spinous dorsal. Soft dorsal and anal with rather low anterior basal scaly sheaths made up of minute scales, and anterior rays of these fins also covered with minute scales. Base of caudal with minute scales, and base of each lobe with a low keel. Base of pectoral naked. Lateral line strongly arched anteriorly till about opposite base of fourth dorsal ray. Scutes strong on sides of caudal peduncle, deepest a little over nine in greatest depth of body.

Origin of spinous dorsal a little behind that of pectoral, spines slender, pungent, third longest, and all depressable in a groove. Soft dorsal with anterior rays elevated, forming a distinct lobe, last ray longer than those immediately preceding, and origin of fin nearly midway between front of eye and base of caudal. Soft anal similar, slightly convex, and origin a little nearer base of caudal than posterior margin of eye. Anal spines depressable in a groove, first inserted about opposite origin of soft dorsal, and second longer. Abdomen keeled before anal spines to anus. Pectoral long, falcate, and nearly reaching a third of straight part of lateral line. Ventral small, inserted a little in advance of origin of pectoral, and about reaching anus. Caudal deeply forked, lobes pointed. Anus well forward, at tips of ventrals.

Color in arrack grayish or slaty-gray above, sides and lower surface white, washed with silvery. Outer portions of dorsals and upper lobe of caudal dusky, other parts and remaining fins yellowish. A small grayish-black blotch on upper edge of opercle. A blackish blotch on inner base of pectoral. Iris yellowish. Peritoneum white.

Length 8 inches.

Type No. 27,512, A. N. S. P. Padang.

Three examples, the type described above, and two young, the larger of which

is $3\frac{3}{8}$ inches long. It has profile less convex, a shorter pectoral, adipose eyelid little developed, and ridge of preopercle more oblique. When received fresh in arrack they were pale leaden-gray above, sides and lower portions white, everywhere silvery. Sides with five deep lead-colored vertical bands fading out below. Spinous dorsal blackish. Opercle with a diffuse dusky blotch on its margin.

(*Semisomnus*, half asleep.)

75. Caranx sem Valenciennes. Plate XIV, upper figure.
76. Carangoides malabaricus (Schneider).
77. Carangoides gibber sp. nov. Plate XV, upper figure to left.

Head $2\frac{5}{6}$; depth $1\frac{2}{3}$; D. VIII—1, 22; A. II—I, 18; scales about 56 in curved portion of lateral line, and about 32 in remaining short straight portion; width of head $2\frac{2}{3}$ in its length; depth of head 1; mandible $1\frac{9}{10}$; third dorsal spine $2\frac{2}{5}$; second dorsal ray $1\frac{2}{3}$; first anal ray $1\frac{7}{8}$; least depth of caudal peduncle 7; pectoral $1\frac{1}{12}$; ventral $2\frac{2}{3}$; snout 3 in head, measured from its tip; eye 3; maxillary $2\frac{1}{4}$; interorbital space $3\frac{1}{2}$.

Body short, deep, ellipsoid, greatly compressed, greatest depth at origin of soft dorsal, and caudal peduncle small and compressed. Upper and lower profiles about evenly convex anteriorly.

Head large, deep, compressed, and rhomboid. Snout a little prominent, short, compressed, oblique, blunt, and upper jaw scarcely projecting. Eye rather large, in middle of length of head. No adipose eyelid. Mouth small, oblique, and mandible projecting beyond upper jaw. Maxillary small, its upper edge slipping under preorbital anteriorly, and its distal expanded extremity, which is equal to half of eye reaches opposite front rim of same. Teeth minute, equal, and forming narrow bands of two or more series in jaws. Vomerine and palatine teeth reduced to minute asperities, none on tongue. Tongue small, elongate, rounded and free in front. Lips rather thin. Nostrils rounded, close together, high, and close to front of eye above. Interorbital space narrow, elevated, and giving place to rather high median trenchant ridge running to spinous dorsal. Preorbital broad, nearly equal to eye. Two supraocular ridges running up from eye posteriorly.

Gill-opening large, carried forward a little in front of nostrils. Gill-rakers 8 + 23, a little longer than filaments, pointed, compressed, about two and one-third in eye. Pseudobranchiæ rather small. Isthmus narrowly compressed, and with a narrow median groove.

Scales minute, and narrowly imbricated. Breast naked, including base of pectoral. Base of spinous dorsal with a narrow scaly sheath, and basal scaly sheaths along anterior portions of soft dorsal and anal. Base of caudal scaly, without keels at bases of lobes. Lateral line strongly arched till about opposite middle of base of soft dorsal, remaining straight portion armed with small weak scutes, broadest not more than half least depth of caudal peduncle. Upper side of head posteriorly and cheek scaled, rest of head naked.

Origin of spinous dorsal well behind origin of pectoral, third spine longest, and all depressable in a groove. Origin of soft dorsal midway between front rim of orbit and base of caudal, anterior rays elongate, first developed longest, and last not

especially elongate. Soft anal similar, first ray longest, and origin of fin a little posterior. Anal spines small, second larger, and first inserted opposite origin of soft dorsal. A short bony keel from anal spines to anus. Caudal small, triangular, forked, and lobes sharply pointed. Pectoral rather broad, falcate, and not reaching beginning of straight part of lateral line. Ventral small, inserted below pectoral, and hardly reaching half way to origin of soft anal.

Color in arrack grayish or slaty-brown above, sides and lower surface whitish, washed with silvery. Fins plain pale or dilute brown, dorsals slightly dusky. No opercular spot. Peritoneum silvery.

Length $3\frac{1}{4}$ inches.

Type No. 27,517, A. N. S. P. Padang.

One example. This species is closely related to *Carangoides malabaricus*, differing in its deeper body and in absence of opercular spot.

(*Gibber*, hunch-back.)

78. Carangoides oblongus (Valenciennes).
79. Citula armata (Forskål).
80. Citula atropos (Schneider). Plate XIV, lower figure to left.
81. Scyris indica Rüppell.
82. Trachinotus ovatus (Linnæus).

RACHYCENTRIDÆ.

83. Rachycentron pondicerianus (Cuvier).

STROMATEIDÆ.

84. Apolectus niger (Bloch).

LEIOGNATHIDÆ.

EQUULITES subgen. nov.

Type *Leiognathus vermiculatus* sp. nov.

Mouth protractile downward. Breast and chest entirely scaled. Lateral line incomplete.

("*Cavalla* est le nom portugais du maquereau et *equula* sa traduction" [Cuvier].)

85. Leiognathus vermiculatus sp. nov. Plate XV, lower figure to left.

Head $3\frac{1}{4}$; depth $2\frac{1}{10}$; D. VIII, 16; A. III, 13; P. II, 14; V. I, 5; scales 48 in lateral line to base of caudal; about 12 scales between origin of dorsal and lateral line; width of head $2\frac{1}{5}$ in its length; depth of head $1\frac{1}{4}$; snout 3; eye 3; tip of snout to end of maxillary $2\frac{3}{7}$; interorbital space 3; second dorsal spine $1\frac{2}{3}$; second anal spine 2; least depth of caudal peduncle $4\frac{2}{3}$; pectoral $1\frac{1}{2}$; ventral $2\frac{3}{5}$.

Body rather elongate, compressed, and greatest depth at origin of spinous anal. Caudal peduncle compressed, its exposed length two-thirds its depth.

Head rather deep, compressed, upper profile greatly inclined, nearly straight, and lower profile with a small process about opposite front of pupil. Snout rather long, blunt. Eye a little anterior and high. Mouth inferior, upper jaw projecting a trifle beyond mandible. Profile of chin slightly concave, nearly straight. Gape not reaching more than two-fifths of space to eye. Mouth protractile downward.

Teeth fine, small, weak, and brush-like, in jaws. Lips broad and fleshy. Nostrils close together, near front of eye a little above its middle, and anterior with a small fleshy flap behind. A single preocular spine. Interorbital space a little elevated, with a median ridge and a parietal ridge well separated on each side. Supraocular ridge entire. Occipital ridge distinct. Lower edge of preopercle minutely serrated.

Gill-opening extending forward opposite front rim of pupil. About 4 + 15 gill-rakers at least, developed on first arch, short, longest much less than longest filaments, which are about a third of eye. Pseudobranchiæ large. Shoulder girdle, inside gill-opening, with three processes, first opposite origin of pectoral, second just below its base, and third close to second. Isthmus broad, gill-membranes broadly connected.

Scales small, narrowly imbricated, and extending on chest. Scaly sheaths along bases of spinous dorsal and anal. Soft dorsal and anal with a series of inconspicuous spines on each side directed backward. Ventral flap as long as spine. Base of caudal scaly. Abdomen narrowly compressed and sharply trenchant, just before anal, half way to root of ventral. A short median groove on process of chest. Two small keels running forward from bases of ventrals rather close together. Lateral line convex most all of its course and obliterated on upper surface of caudal peduncle. Pores and scales in its course large. Back rather trenchant before spinous dorsal.

Origin of spinous dorsal about over first two-fifths of pectoral, second spine highest, and others graduated down. Front edges of third and fourth dorsal, and third anal spines finely serrate on basal portion. Second anal spine largest. Insertion of spinous anal about midway between tip of snout and base of caudal. Soft dorsal and anal low, similar. Caudal forked, lobes broad and pointed. Pectoral small, origin but little below middle of depth of body, and reaching posteriorly opposite origin of spinous anal. Ventral small, inserted a little behind origin of pectoral, and reaching a trifle over half way to origin of spinous anal. Anus nearly midway between base of ventral and origin of spinous anal.

Color in arrack pale brown on upper half of body, lower half white. Body everywhere more or less silvery, and line separating dark color of back distinct. Upper half of body marked with variable lines and blotches or vermiculations of brown. Snout with a blackish-brown bar from its tip up to nostrils. Inside of gill-opening dusky. Fins more or less dilute yellowish, dorsal a shade darker. Axil of pectoral with brown dots. Peritoneum silvery, with brown dots.

Length $4\frac{1}{4}$ inches.

Type No. 27,525, A. N. S. P. Padang.

One example. This species is closely related to *Equula lineolata* Valenciennes. The original description of the latter is imperfect, and neither Bleeker or Dr. Günther give the scales found in a lateral count, or counted in the lateral line. Day states the lateral line "consists of above 60 tubes placed in a row of plate-like rounded scales." His figure does not agree with my fish, especially in the

vertical dark bars on back. In all of these accounts of *lineolata* the body is more elongate.

(*Vermiculatus*, from color marks simulating the tracks of worms.)

86. LEIOGNATHUS VIRGATUS sp. nov. Plate XV, lower figure to right.

Head $3\frac{2}{3}$; depth $1\frac{7}{8}$; D. VIII, 16; A. III, 14; P. II, 14; V. I, 5; pores with first 20 or more distinct, others obliterated; width of head 2 in its length; depth of head 1; second dorsal spine $1\frac{7}{8}$; second anal spine $2\frac{1}{8}$; pectoral $1\frac{1}{3}$; ventral $2\frac{2}{3}$; least depth of caudal peduncle $4\frac{1}{4}$; snout $3\frac{1}{2}$ in head, measured from its tip; eye $2\frac{2}{3}$; tip of snout to end of maxillary $2\frac{1}{3}$; interorbital space $3\frac{1}{5}$; upper caudal lobe $3\frac{1}{4}$ in body, from tips of jaws.

Body deep, compressed, upper and lower profiles nearly evenly convex, and greatest depth about origin of spinous dorsal. Caudal peduncle compressed, and its exposed length about four-fifths its least depth.

Head deep, compressed, and upper profile convex, concave, and again convex. Lower profile forming an obtuse angle at slight articular process. Snout high, broadly conic, and with upper jaw projecting beyond. Eye a little anterior, and high in head. Jaws equal, mouth terminal, and gape reaching about opposite first two-fifths of length of snout. Profile of chin straight. Mouth protractile downwards. Teeth small, fine, brush-like, and in a single series in jaws. Lips rather thin. Maxillary with its upper margin nearly vertical and opposite front rim of orbit. Nostrils more or less facing forward, lateral, adjoining, near front of eye, and posterior twice as large as anterior. Interorbital space a little elevated, with a median low ridge, and a parietal ridge widely separated on each side, sharp, and leaving a broad space between. Occipital ridge distinct. Two small spines in front of eye above, anterior with two prongs. Supraorbital ridge a little rough, almost entire. Lower edge of preoperculum finely serrated.

Gill-opening extending forward opposite front rim of orbit. Gill-rakers 6 + 18, slender, pointed, more or less equal, and a little less than filaments. Pseudobranchiæ large, about half of orbit. Shoulder girdle inside with three processes, first opposite origin of pectoral, second opposite lower base of pectoral, and third obsolete and well separated. Isthmus broad and rounded.

Scales small, narrowly imbricated, weak, and extending on chest and breast. Scaly sheaths along bases of spinous dorsal and anal. Soft dorsal and anal with a series of inconspicuous spines along their bases on each side. Ventral flap equal to its spine. Base of caudal scaly. Abdomen narrow, compressed, sharply trenchant just before spinous anal, and reaching a little more than half way to origin of ventral. A short median convex process on chest. Two small keels close together, each running forward from root of ventral to chest process. Lateral line convex, running for half of base of dorsal, becoming indistinct, and finally obliterated after spinous dorsal. Pores large. Back trenchant before spinous dorsal.

Origin of spinous dorsal over first quarter of pectoral, second spine longest, enlarged, and others graduated down. Soft dorsal low, origin of fin about midway

between front rim of eye and base of caudal. Origin of spinous anal nearly midway between tips of jaws and base of last anal ray, second spine enlarged. Lower front edges of third and fourth dorsal, and third anal spines, finely serrate. Soft anal similar to soft dorsal. Caudal forked, lobes rather broad, and pointed. Ventral small, reaching a little over half way to origin of spinous anal. Pectoral small, short, and reaching about opposite base of second anal spine. Anus nearer base of ventral than origin of spinous dorsal.

Color in arrack pale brownish-gray on upper half of body, marked or variegated with short darker blotches or vermiculations. Lower half of body white. Body everywhere more or less bright silvery. Snout dusky. Fins more or less dilute brownish-yellow. Spinous parts of vertical fins more or less burnished with silvery, and spinous dorsal with a blackish cross-line a little below center of its height. Base of pectoral marked with pale brown dots on inside. Inside of gill-opening similar. Iris pale orange. Peritoneum silvery.

Length $4\frac{9}{16}$ inches.

Type No. 27,526, A. N. S. P. Padang.

Five examples. This species is related to *Leiognathus bindoides* (Bleeker),[1] differing in the black bar on dorsal, preocular spines more obsolete, and absence of golden spots on spinous dorsal.

(*Virgatus*, striped with reference to black band on spinous dorsal.)

EUBLEEKERIA subgen. nov.

Type *Equula splendens* Cuvier.

Differs from *Equulites* in complete lateral line.

(Named for Dr. Pieter van Bleeker, the most voluminous of writers in Ichthyology, and whose work on the fishes of Sumatra is the most complete ever given.)

87. Leiognathus splendens (Cuvier).

88. Leiognathus spilotus sp. nov. Plate XIV, lower figure to right.

Head $3\frac{1}{10}$; depth $2\frac{1}{6}$; D. VIII, 16; A. III, 14; P. I, 13; V. I, 5; width of head $2\frac{2}{3}$ in its length; depth of head 1; snout $3\frac{1}{2}$; eye $2\frac{3}{5}$; interorbital space $3\frac{1}{3}$; tip of snout to end of maxillary $2\frac{3}{5}$; second dorsal spine $1\frac{2}{5}$; caudal $1\frac{1}{4}$; pectoral $1\frac{1}{3}$; ventral 2; least depth of caudal peduncle 5.

Body elongate, greatly compressed, greatest depth at origin of dorsal, and upper profile more or less convex from this point. Caudal peduncle compressed.

Head deep, compressed, and upper profile slightly and evenly convex. Snout short, blunt, and upper jaw not projecting. Eye rather large, anterior. Mouth small and protractile downward. Teeth fine, weak, brush-like, and uniserial in jaws. Preocular spines two. Parietal ridges well separated. Occipital ridge developed. Profile of chin strongly concave. Supraorbital ridge serrate. Lower margin of preopercle serrate.

Gill-opening extending forward opposite posterior margin of pupil. Rakers small, pointed, much smaller than filaments. Pseudobranchiæ well developed.

[1] *Equula bindoides* Bleeker, Nat. Tijds. Ned. Ind., I, 1850, p. 372. Batavia, in mari.

Scales all fallen and hardly a trace of lateral line. Pockets on chest and breast indicate that it was scaled. Bases of spinous dorsal and anal with a scaly sheath. Two conical processes on chest with a groove between, and a low keel forward from base of each ventral, space between narrow.

Spinous dorsal inserted a little behind origin of pectoral, second spine enlarged and longest. Second anal spine largest, and origin of fin a little nearer tip of snout than base of caudal. Caudal deeply forked, and lobes rather broad. Pectoral reaching at least opposite base of second anal spine. Ventral small, inserted below origin of pectoral, and reaching two-thirds of distance to anal.

Color in arrack with upper half of body plain pale brownish-gray, lower half white. Body everywhere more or less bright silvery. Back with several rows of brownish blotches, two or three blotches to a row, and line of demarcation distinct. Fins dilute brown or whitish, spinous dorsal black on membranes of upper half. Inner base of pectoral dark brown. Iris whitish.

Length $1\frac{5}{16}$ inches.

Type No. 27,529, A. N. S. P. Padang.

One example. This may prove to be the young of *Leiognathus blochii* (Valenciennes). An indistinct brown saddle-like blotch in front of spinous dorsal on the back. Day's description and figure of *Equula blochii* differ in the posterior dark-colored base of pectoral.[1]

(Σπιλωτὸς, spotted.)

Subgenus LEIOGNATHUS Lacépède.

Differs from *Equulites* in naked breast and chest.

89. Leiognathus edentulus (Bloch).

DEVEXIMENTUM gen. nov.

Type *Zeus insidiator* Bloch.

This genus differs from *Leiognathus* in the nearly vertical mandible, so that the mouth is protractile horizontally.

(*Devexum*, hanging, or declining down; *mentum*, chin.)

90. Deveximentum insidiator (Bloch).
91. Gazza tapeinosoma (Bleeker). Plate XV, upper figure to right.
92. Gazza minuta (Bloch).
93. Pentaprion longimanus (Cantor).

MENIDÆ.

94. Mene maculata (Schneider).

LACTARIIDÆ.

Body oblong, compressed. Head compressed, with *Percoidean* aspect. Snout conic. Eyes lateral. Mouth cleft deep and oblique. Teeth small in the jaws, with one or two pairs of canines in front. Margin of preopercle entire. Gill-opening large. Gill-rakers long. No processes on the shoulder girdle inside the gill-opening. Branchiostegals seven. Pseudobranchiæ present. Peritoneum pale. Scales of moderate size, cycloid, and extending partially over the fins. Lateral line continu-

[1] Fishes of India, II, 1876, p. 241, plate 52, fig. 5.

ous. Air-vessel bifurcated both anteriorly and posteriorly. Pyloric appendages few. Two dorsal fins. Spinous dorsal with feeble spines. Three feeble anal spines. Soft dorsal and anal with many rays. Caudal forked.

This family contains the single genus *Lactarius*, of the Indian and Malayan seas. It approaches the *Carangidæ*, especially "*Serioloidei*" according to Bleeker, while on the other hand it has affinities with the *Sciænidæ* according to Dr. Günther.

LACTARIUS Valenciennes.

Lactarius Valenciennes, Hist. Nat. Poiss., IX, 1833, p. 177 (*delicatulus* = *lactarius*).

95. LACTARIUS LACTARIUS (Schneider).

Scomber lactarius Schneider, Syst. Ichth., 1801, p. 31. Tranquebariam.

One example, $4\frac{5}{8}$ inches long. The species is carnivorous. Macerated remains of several young fishes were taken from the gullet.

APOGONIDÆ.

96. APOGON HYALOSOMA Bleeker.

Subgenus OSTORHINCHUS Lacépède.

Ostorhinchus Lacépède, Hist. Nat. Poiss., IV, 1803, p. 23 (*fleurieu*).

97. APOGON EVANIDUS sp. nov.

Head $2\frac{1}{3}$; depth $2\frac{5}{6}$; D. VII—I, 9; A. II, 8; P. II, 14; V. I, 5; scales 24 in lateral line to base of caudal, and 4 more continued out on base of latter; 2 scales between origin of dorsal and lateral line, and 5 scales in an oblique series between latter and origin of anal; width of head $2\frac{2}{5}$ in its length; depth of head $1\frac{1}{3}$; mandible $1\frac{4}{5}$; third dorsal spine $2\frac{3}{4}$; second dorsal ray $1\frac{7}{8}$; second anal spine 4; first anal ray $2\frac{1}{4}$; pectoral $1\frac{3}{4}$; ventral $1\frac{4}{5}$; ventral spine $3\frac{1}{5}$; least depth of caudal peduncle $2\frac{3}{4}$; snout $4\frac{1}{3}$ in head, from tip of upper jaw; eye $3\frac{1}{2}$; maxillary $2\frac{1}{10}$; interorbital space about $5\frac{1}{2}$.

Body elongate, compressed, and back a little elevated. Caudal peduncle long, and compressed, its least depth nearly one and two-thirds in its length.

Head large, compressed, and lower profile a little convex, upper much inclined and more or less straight. Snout short, broad, convex, and upper jaw projecting a little. Eye high, large, and its posterior rim about midway between tip of upper jaw and end of opercular flap. Mouth large, slightly curved, and mandible projecting well in front. Maxillary large, reaching posteriorly below posterior margin of pupil, and its distal expanded extremity half of eye. Teeth in jaws minute, in narrow bands. Patch of minute teeth on vomer. Palatines edentulous. Tongue smooth, small, rounded and free in front. Nostrils separated, posterior larger, close to front rim of orbit, and anterior much nearer latter than tip of upper jaw. Top of head a little convex posteriorly, interorbital space flattened. Margin and ridge of preopercle inclined a little posteriorly, former finely denticulated, and latter with one or two short denticulations at its corner. Opercle with a small broad spine, and large flap. Preorbital narrow.

Gill-opening till about opposite space between nostrils. Gill-rakers about 4+13,

longest longer than filaments, or about two-fifths of orbit. Pseudobranchiæ small. Isthmus rather broad and trenchant.

Scales large, ctenoid. Two series of large scales on cheek, opercles scaled, and rest of head naked. Base of caudal scaly, fins otherwise naked. Lateral line more or less concurrent with dorsal profile, and continuous.

Origin of spinous dorsal a little behind that of pectoral or a little nearer tip of mandible than tip of depressed second dorsal, and fourth spine longest. Anterior dorsal rays longest, and origin of fin about midway between middle of eye and base of caudal. Origin of anal about opposite that of soft dorsal, and similar in shape. Second anal spine much longer than first. Caudal a little emarginate. Pectoral long, reaching opposite origin of spinous anal. Ventral inserted a little before origin of pectoral and reaching within but a short distance of origin of spinous anal. Ventral spine about four-sevenths length of fin.

Color in arrack more or less pale uniform brown, lower surface not especially lighter. A dull brown diffuse stripe from occiput along back above to upper edge of caudal peduncle. Another band from snout continued behind eye where it is narrow, along middle of side where it widens, and out over caudal to tips of median rays. Below this a pale band longitudinally from axil of pectoral, but fading out over anal. Chin pale dusky. Fins dilute brown, and a trifle dusky on their outer portions, especially ventrals. A narrow dusky band close to base and parallel with it on soft dorsal and anal. Bases of these fins whitish. Iris a little brownish. Peritoneum silvery, speckled and spotted with grayish.

Length $3\frac{5}{16}$ inches.

Type No. 27,540, A. N. S. P. Padang.

Two examples. This species has been confounded under the name *Apogon frenatus* by authors. Valenciennes' account and figure[1] agree well with Bleeker's,[2] but Day's figure[3] represents a different fish. The latter certainly represents the examples before me, agreeing in every respect. *Apogon vittiger* Bennett[4] is probably close to if not identical with *Apogon frænatus* Valenciennes. *Apogon melanorhynchos* Bleeker[5] also has claims, in part, to separation. *Apogon frenatus* Günther,[6] judging by the incomplete description, may be the same as that of Valenciennes, but the examples described and figured later[7] are close to if not identical with Day's figure.

(*Evanidus*, flashy, vain.)

98. Apogon novemfasciatus Cuvier.

99. Archamia bleekeri (Günther).

[1] *Apogon frænatus* Valenciennes, Nouv. Ann. Mus. Hist. Nat. Paris, I, 1832, p. 57, plate 4, fig. 4. Nouvelle-Guinée, et à l'ile Guam.

[2] *Amia frenata* Bleeker, Atlas Ichth., VII, 1876, p. 89, and l. c., VIII, 1876, plate 342 (64), fig. 2. [East Indies.]

[3] *Apogon frenatus* Day, Fishes of India, Atlas, I, 1875, plate 16, fig. 4. [India.]

[4] Proc. Zoöl. Soc. London, 1833, p. 32. Mauritius. (Mr. C. Telfair.)

[5] *Apogon melanorhijnchos* Bleeker, Nat. Tijds. Ned. Ind., III, 1852, p. 255. Wahai, Ceram septentrionalis, in mari.

[6] Cat. Fish. Brit. Mus., I, 1859, p. 241. Feejee Islands.

[7] Journ. Mus. Godef. (Fische der Südsee), I, 1873, p. 19, plate 19, fig. a. Sandwich-Gesellschafts-und Paumotu-Inseln. (Mr. Andrew Garrett.)

SERRANIDÆ.

100 Plectropoma pessuliferum sp. nov. Plate XVII, upper figure.

Head 3; depth $3\frac{4}{5}$; D. VII, II, 11; A. III, 8; P. I, 15; V. I, 5; scales 132 in a lateral series to base of caudal; 18 scales in an oblique series between origin of spinous dorsal and lateral line, and 28 in a vertical transverse series between latter and origin of anal; width of head 2 in its length; depth of head $1\frac{1}{2}$; mandible 2; third dorsal spine $3\frac{3}{4}$; first developed dorsal ray $2\frac{1}{2}$; first anal ray $2\frac{1}{2}$; least depth of caudal peduncle $2\frac{2}{3}$; pectoral $2\frac{1}{8}$; ventral $2\frac{1}{12}$; caudal $1\frac{1}{3}$; snout $2\frac{9}{10}$, from tip of upper jaw; eye $6\frac{3}{4}$; maxillary $2\frac{1}{4}$; interorbital space 5.

Body oblong, compressed, and greatest depth near middle of spinous dorsal. Caudal peduncle large, compressed, and its greatest depth three-quarters its length.

Head elongate, compressed, rather pointed, and profiles about evenly convex. Snout moderate, convex, and upper jaw well projecting. Eye small and high. Mouth curved, oblique, jaws large, and lower protruding. Maxillary large, expanded distally till about seven-eighths of orbit, and reaching posteriorly about opposite front rim of pupil. Lips broad, thick, and fleshy. Teeth conic, sharp, some of outer erect, inner more or less depressable, and each jaw with two well separated canines. Vomerine and palatine teeth minute. Tongue small, narrow, broadly pointed and free in front. Nostrils close together, circular, anterior with a little fleshy rim, and posterior much larger, placed about last two-fifths of snout in front of lower part of eye. Interorbital space and top of head convex. Lower margin of preopercle with about three low obsolete spines directed down and forward. Opercular spines two, lower forward, and much smaller than upper.

Gill-opening large, extending forward nearly opposite posterior nostril. Gill-rakers 3 + 9, compressed, strong, longest equal to gill-filaments, or about three-fifths of orbit, and inner surfaces with large asperities. Pseudobranchiæ well developed. Isthmus broad, with a short groove in front, and constricted edge rounded.

Scales small, mostly somewhat oblong, and finely ciliated. Head, with exception of snout, lips, greater portion of maxillary, branchiostegal region, narrow space around eye, and interorbital region, covered with small scales. Basal portions of soft dorsal, anal, and caudal covered with small scales. Axil of pectoral with a pit, covered above with a small fleshy flap. Lateral line continuous, a little convex in front, and not pronounced.

Spinous dorsal lower than soft fin, continuous, inserted a little behind origin of pectoral, and spines about even, except first, which is shortest. First two dorsal rays not much branched, insertion of fin about midway between middle of eye and base of caudal. Anal inserted a little nearer base of caudal than origin of pectoral, spines flexible distally and graduated to last, which is longest. Caudal large, broad, and emarginate. Pectoral broad, rounded, and middle rays longest. Ventral pointed, inserted a trifle before pectoral, and reaching a little beyond same. Anus about last three-ninths of space between tips of ventrals and origin of spinous anal.

Color in arrack yellow, more or less tinged with orange below and pinkish above. Body marked with many blue spots with dark brown edges, rather large

on head and back, a few of those on middle of trunk formed into short vertical bars, and those extending out on caudal, soft dorsal, and anal rather numerous. Pectoral plain, deep orange. Ventral, also anal and caudal, tinged with deep orange. Iris pale orange. Peritoneum pale or whitish.

Length $16\frac{5}{8}$ inches.

Type No. 27,546, A. N. S. P. Padang.

One example. It is closely related to *Paracanthistius maculatus* Bleeker.[1] Distinguished by a number of short vertical dark bars on the middle of side, and the more spotted caudal fin.

(*Pessulus*, a little bar; *fero*, to bear; with reference to the short dark vertical bars on side.)

101. Variola louti (Forskål).
102. Petrometopon pachycentron (Valenciennes).
103. Petrometopon formosus (Shaw and Nodder).
104. Petrometopon cyanostigma (Valenciennes).
105. Bodianus indelebilis sp. nov. Plate XVII, lower figure.

Head $2\frac{1}{2}$; depth $2\frac{2}{3}$; D. IX, 15; A. III, 9; P. I, 17; V. I, 5; scales 72 in a lateral series to base of caudal, 15 between origin of dorsal and lateral line obliquely, and about 29 between latter and origin of anal; pores about 40 in lateral line to base of caudal; width of head $2\frac{1}{4}$ in its length; depth of head $1\frac{2}{5}$; mandible $1\frac{4}{5}$; fourth dorsal spine $3\frac{3}{7}$; seventh dorsal ray $2\frac{4}{5}$; second anal spine $2\frac{2}{3}$; sixth anal ray $2\frac{2}{3}$; caudal $1\frac{9}{10}$; least depth of caudal peduncle $3\frac{1}{8}$; pectoral $1\frac{4}{7}$; ventral 2; snout 4 in head, from tip of upper jaw; eye $5\frac{1}{2}$; maxillary 2; interorbital space $7\frac{1}{2}$.

Body elongate, compressed, and upper profile forming a regular even convex curve to caudal peduncle. Greatest depth about origin of ventral. Caudal peduncle compressed, deep, and its length about five-sixths its depth.

Head rather large, compressed, somewhat pointed, and both profiles more or less convex. Snout short, convex, and upper jaw prominently projecting. Eye small, high, and well anterior. Mouth large, a little inclined, and lower jaw well protruding. Maxillary large, reaching opposite eye posteriorly, and distally expanded till equal to four-fifths of orbit. Teeth small, sharp pointed, and inner ones depressable. An outer series of strong erect teeth in each jaw, upper but little if any larger. Lower inner depressable teeth, also those in front of upper jaw, enlarged. Two canines in front of each jaw, well separated, and upper ones twice as far apart as lower. Vomer and palatines with small teeth. Tongue long, narrow, free, and with a rounded tip. Lips thick and tough Nostrils close together near front of eye, and anterior in a short tube. Interorbital space more or less level, with a depression in front. Margin of preopercle with minute serræ. Three opercular spines, uppermost distant, directed a trifle upward, and lowest most anterior.

Gill-opening extending forward to middle of orbit. Gill-rakers IV 2 + 11 IV, compressed, about equal to gill-filaments or two-fifths of orbit. Pseudobranchiæ about equal to gill-filaments. Isthmus broad, with a broad depression in front and constricted behind, edge not trenchant.

[1] Atlas Ichth., VII, 1876, p. 26, plate 291 (13), fig. 3.

Scales small and finely ciliated. Head scaled, except lips, greater part of maxillary, and snout. Scales on head more or less smooth, those on maxillary small. Fins with greater basal portion covered with small scales. Ventral with but a few basal scales. A scaly flap at base of pectoral over axillary pit. Lateral line continuous, convex till below bases of fifth and sixth dorsal spines, and then inclined in a more or less straight line till along middle of side of caudal peduncle to base of caudal. Scales on top of head, back in front of spinous dorsal, and cheek, much reduced and crowded.

Origin of spinous dorsal a little behind that of pectoral, and spines graduated to fourth, after which all are more or less even and lower than soft dorsal. Origin of soft dorsal inserted much nearer origin of pectoral than base of caudal, rays more or less uniform, and posterior edge of fin rounded. Second anal spine a little longer than third, fin inserted also a little nearer origin of pectoral than base of caudal, lower edge straight, and posterior edge rounded. Caudal rounded. Pectoral long, broad, rounded, expanded, and reaching opposite origin of anal. Ventral reaching more than four-fifths to anus, spine three-fifths length of fin.

Color in arrack orange, faded a little, and many of scales on upper part of body with pale dusky. Head and back in front with small round golden spots. On margin of soft dorsal at thirteenth ray a brown spot equal to pupil. Anal and ventral with a narrow dusky margin. Caudal with a narrow whitish line close to and concurrent with edge of fin. Pectoral deep golden-orange. Iris golden-yellow. Inside of gill-opening with more or less faded orange-yellow. Peritoneum silvery.

Length $7\frac{1}{8}$ inches.

Type No. 27,553, A. N. S. P. Padang.

One example. Closely related to *Bodianus aurantius* (Cuvier), differing in the pale submarginal band and the dark spot on thirteenth dorsal ray. Dr. Boulenger has united *Serranus aurantius* with *S. analis*, after an examination of the types in the Paris Museum.[1] However, the two fishes figured by Bleeker appear to differ.

(*Indelebilis*, not to be blotted out; referring to the dorsal spot.)

106. Bodianus miniatus (Forskål).

ÆTHALOPERCA subgen. nov.

Type *Perca rogaa* Forskål.

Closely related to *Bodianus*, differing in the physiognomy, which somewhat suggests that of *Lobotes* and certain *Lutianidæ*. Soft dorsal and anal nearly forming right-angled lobes. Caudal truncate. Ventral as long as pectoral. Caudal peduncle deep. Snout with a straight profile, then upper profile strongly convex to dorsal so that back is elevated.

(Αἴθαλος, dark-colored, sooty, or blackened; πέρκη, perch.)

107. Bodianus rogaa (Forskål).

108. Epinephelus heniochus sp. nov. Plate XVIII, upper figure.

[1] Cat. Fish. Brit. Mus., Ed. II, I, 1805, p. 193. N. Celebes. (Dr. A. B. Meyer.) Louisiade Archipelago. (Mr. J. Macgillivray.)

Head $2\frac{1}{3}$; depth $3\frac{1}{6}$; D. XI, 15; A, III, 8; P. II, 15; V. I, 5; scales 87 in a lateral series to base of caudal, 16 in an oblique series between origin of spinous dorsal and lateral line, and 25 between latter and origin of anal; pores 52 in lateral line to base of caudal, and about 5 more on base of latter; width of head $2\frac{3}{5}$ in its length; depth of head $1\frac{3}{4}$; mandible $1\frac{4}{5}$; third dorsal spine $3\frac{2}{3}$; sixth dorsal ray $2\frac{9}{10}$; third anal spine 4; fourth anal ray $2\frac{3}{4}$; caudal 2; least depth of caudal peduncle $3\frac{5}{6}$; pectoral $1\frac{4}{5}$; ventral $2\frac{2}{5}$; snout $4\frac{1}{5}$ in head, from tip of upper jaw; eye $5\frac{1}{4}$; maxillary $2\frac{1}{5}$; interorbital space $7\frac{2}{3}$.

Body oblong, compressed, back hardly elevated, and greatest depth at origin of ventral. Profiles more or less evenly convex. Caudal peduncle compressed, rather deep, and its length from base of last dorsal ray but little less than its least depth.

Head long, pointed, profile slightly and evenly convex. Snout convex, rather broad. Eye with its center about first third of head, measured from tip of snout. Mouth not much inclined, and mandible projecting well beyond upper jaw. Maxillary large, reaching opposite posterior rim of orbit, and distally expanded till about four-sevenths of latter's diameter. Lips thick and tough. Teeth sharp pointed, conical, and biserial in jaws. Outer series erect, of about equal length in each jaw, and inner series small, depressable and longer in mandible. Teeth irregular in front of each jaw, those above more elongate. Canines in front of each jaw, two smaller ones in lower, and two adjoining on each side of upper well separated. Minute teeth on vomer and palatines. Tongue long, narrow, free, and rounded in front. Nostrils close together near middle of front of eye, and anterior with a fleshy rim forming a short tube. Interorbital space slightly convex, with a slight depression in front. Top of head convex. Posterior margin of opercle finely serrated and ending in two small spines at lower corner. Three opercular spines, upper obsolete though most anterior, and middle largest, slightly directed upward. Opercular flap rather long and pointed.

Gill-opening large and carried forward below posterior nostril. Gill-rakers v 2 + 10 III, compressed, equal in length to gill-filaments, or a trifle less than half of orbit. Pseudobranchiæ about equal to gill-filaments. Isthmus rather broad, with a broad furrow in front and posteriorly with a slightly trenchant edge.

Scales small and finely ciliated. Head covered with more or less smooth scales, except lips and greater portion of maxillary. Scales on maxillary few and inconspicuous. Cheek, top of head, and snout with small scales. Basal portions of fins with minute scales which do not extend far out. A few scales on bases of pectoral and ventral. A broad scaly flap over axillary pit. Lateral line convex till about fifth dorsal spine, then down along middle of side of caudal peduncle to base of caudal.

Spinous dorsal inserted a trifle before origin of pectoral, and graduated to third spine which is longest, and others all more or less equal. Soft dorsal inserted a little nearer base of caudal than origin of pectoral, much higher than spinous dorsal and its posterior edge rounded. Origin of anal a little in front of that of second dorsal, spines graduated to third, which is longest. Soft anal higher than soft dor-

sal, and rounded. Caudal subtruncate, its posterior margin slightly rounded when expanded. Pectoral long, expanded, middle rays longest, fin rounded, and reaching opposite anus. Ventral inserted a little before pectoral, and reaching about three-fifths of distance to anal. Ventral spine strong, straight, and about two-thirds length of fin. Anus about midway between tip of ventral and origin of anal.

Color in arrack rich wood-brown, belly and lower surface paler. A narrow dark brown line from side of snout under eye to base of pectoral, and another similar from above end of maxillary across preopercle on side of head. Another diffuse one also from posterior edge of eye across postocular region. Fins and mouth more or less tinged with dull olive-yellow, former somewhat dusky marginally, except pectoral which is almost uniform pale olive-yellow. Iris brownish-yellow. Peritoneum silvery.

Length 9 inches.

Type No. 27,557, A. N. S. P. Padang.

Two examples, larger 13 inches in length. This species is related to *Epinephelus præopercularis* (Boulenger).[1] It differs in the absence of black dots or spots on upper surface, fewer gill-rakers, fewer lateral pores, vertical fins without a narrow whitish margin. Lower brown streak across preopercle also characteristic of *E. heniochus*.

(Ἡνίοχος, charioteer; the streaks on side of head suggesting a bridle or reins.)

109. Epinephelus maculatus (Bloch).
110. Epinephelus sexfasciatus (Valenciennes).
111. Epinephelus megachir (Richardson).
112. Epinephelus dermochirus Valenciennes).
113. Epinephelus horridus (Valenciennes).
114. Epinephelus lanceolatus (Bloch).

PRIACANTHIDÆ.

115. Priacanthus tayenus Richardson.

LUTIANIDÆ.

116. Evoplites decemlineatus (Valenciennes).

Subgenus LUTIANUS Bloch.

Lutianus Bloch, Ichthyologie, IV, pt. 7, 1797, p. 85 (*lutjanus*).

No gash on lower margin of preopercle, and process opposite obsolete. Forehead scaly.

117. Lutianus madras (Valenciennes).
118. Lutianus vitta (Quoy and Gaimard).
119. Lutianus nouleny (Valenciennes).
120. Lutianus biguttatus (Valenciennes).

BENNETTIA subgen. nov.

Type *Anthias johnii* Bloch.

Interorbital space naked. Scales above and below lateral line following in parallel series. In this respect it resembles *Raizero* Jordan and Fesler.

(Named for Mr. E. T. Bennett, an early writer on the fishes of Sumatra.)

[1] *Serranus præopercularis* Boulenger, Proc. Zoöl. Soc. London, 1887, p. 654. Muscat. (Mr. A. S. G. Jayakar.)—*Epinephelus præopercularis* Boulenger, Cat. Fish. Brit. Mus., Ed. II, I, 1895, p. 207, plate 5.

121. LUTIANUS JOHNII (Bloch).

PARKIA subgen. nov.

Type *Lutianus furvicaudatus* sp. nov.

Hobar Forskål, Descript. Annimal., 1775, p. 44 (*fulviflamma*). [Uncertain.]

Interorbital space naked. Scales above lateral line sloping up in oblique series more or less, to base of dorsal fin.

(Named for Mungo Park, the first writer on the fishes of Sumatra.)

122. LUTIANUS LEPISURUS (Lacépède).
123. LUTIANUS LUNULATUS (Park).
124. LUTIANUS LINEATUS (Quoy and Gaimard).
125. LUTIANUS VAIGIENSIS (Quoy and Gaimard).
126. LUTIANUS LIOGLOSSUS Bleeker.
127. LUTIANUS RUSSELLII (Bleeker).
128. LUTIANUS DECUSSATUS (Cuvier).
129. LUTIANUS CÆRULEO-PUNCTATUS (Cuvier).
130. LUTIANUS ROSEUS Day.
131. LUTIANUS FURVICAUDATUS sp. nov. Plate XVIII, lower figure.

Head $2\frac{1}{2}$; depth $2\frac{9}{10}$; D. X, 13; A. III, 8; P. II, 14; V. I, 5; scales 50 in a lateral series to base of caudal below lateral line; 9 scales in a slightly oblique forward series between origin of spinous dorsal and lateral line, and 17 between latter and origin of anal; pores 49 in lateral line to base of caudal; width of head $2\frac{3}{5}$ in its length; depth of head at posterior margin of eye $1\frac{4}{7}$; mandible 2; third dorsal spine $2\frac{3}{4}$; tenth $3\frac{1}{2}$; fifth dorsal ray $2\frac{5}{6}$; second anal spine $3\frac{1}{5}$; first anal ray $2\frac{2}{5}$; least depth of caudal peduncle $3\frac{1}{8}$; upper caudal lobe $1\frac{1}{3}$; pectoral $1\frac{1}{3}$; ventral $1\frac{2}{3}$; snout $2\frac{7}{10}$, from tip of upper jaw; eye $4\frac{1}{3}$; maxillary $2\frac{3}{7}$; interorbital space $5\frac{3}{4}$.

Body elongate, compressed, rather slender, and back somewhat elevated, with a more or less curved profile. Caudal peduncle compressed, and its least depth about one and one-quarter in its length.

Head elongate, pointed, compressed, and upper profile straight from tip of upper jaw to occiput, though well inclined. Snout rather long, convex, profile straight, and upper jaw projecting. Preorbital a little less in width than vertical diameter of eye. Eye a little longer than deep, a little anterior, and high in head. Mouth rather small, slightly inclined horizontally, and curved. Lips thick, rather broad, fleshy, and papillose on their inner edges. Lower jaw projects well beyond upper. Maxillary reaching a trifle beyond front of eye, and its distal expanded extremity one and three-quarters in horizontal diameter of orbit. A narrow inner series of fine teeth in jaws, but only in front of lower. An outer series of enlarged sharp pointed conic teeth in each jaw, those on sides and front of mandible enlarged, and a pair of large canines in upper well separated. Minute teeth on vomer, palatines, and tongue, in a V-shaped patch on former. Tongue rather long, rounded, and free in front. Nostrils well separated, anterior with a slightly elevated fleshy rim, much nearer front of eye than tip of snout, and posterior about midway between front of eye and anterior. Interorbital space a trifle convex. Margin of preopercle finely serrated, with a slight excavation below opposite rather obsolete interopercular process. Opercle with two broad processes. Opercular flap rather obtuse.

Gill-opening extending forward nearly opposite posterior nostril. Gill-rakers

v 2 + 10 ii, compressed, with rather coarse pricks on inner surfaces, and longest a third longer than longest filaments, or one and three-quarters in eye. Pseudobranchiæ equal to longest gill-filaments. Isthmus compressed and with a rather shallow groove in front.

Scales moderate, finely ciliated, those on middle of side a little large, sloping up in inclined series above lateral line to upper profile, and below it in horizontal series. Seven series of scales on cheeks. Scales on opercle, subopercle and interopercle, largest on former. Two broad opercular spines, upper anterior. Opercular flap blunt. Suprascapula with serrated edge. Small scales crowded along base of spinous dorsal, and small patches elevated alternately. Small scales crowded on bases of other vertical fins and well out between rays of soft dorsal and anal. Caudal basally with small crowded scales, margin broadly and greater portions of median rays bare. Small scales crowded at base of pectoral, and also extending on bases of rays. Ventral naked and with a small pointed scaly flap at its base. Lateral line a little convex in front, and inclined more or less straight till out on median basal portion of caudal, running well up on caudal peduncle at first. Scales in lateral line small and with a large concealed single tube. Patch of oblique scales on upper side of head broad and high up.

Origin of spinous dorsal about over that of pectoral, spines graduated to third, second equal to eighth, first a trifle over half length of last, and margin of fin deeply notched. First dorsal ray simple, about midway between origin of pectoral and base of caudal, margin of fin straight, rounded behind, and first rays highest. Anal inserted opposite base of second dorsal ray, second and third spines equal, first rays longest, and base of rayed portion one and two-thirds in its height. Caudal emarginate, pointed above and below. Pectoral rather small, pointed, and reaching a little past anus, but not to anal. Ventral placed a trifle behind base of pectoral, and ending in a short filament. Anus at tips of ventrals.

Color in arrack deep brown above, lower surface silvery-white. Indistinct dusky-brown lines obliquely up from lateral line, and rather narrow. Below lateral line a number of indistinct horizontal lines, fading out below. These also extend on side of head and cheek, but indistinct at present. Caudal, with exception of slightly paler posterior margin, deep blackish-brown. Dorsals, anal and pectoral grayish-brown. Ventral pale orange, now much faded. Lower lip dusky. Iris dull golden, with a brown blotch above. Peritoneum silvery.

Length $7\frac{3}{8}$ inches.

Type No. 27,596, A. N. S. P. Padang.

One example. This species is related to *Lutianus argentimaculatus* (Forskål). The uniform dark caudal and oblique and horizontal stripes in combination will however distinguish *L. furvicaudatus* from this and other allied species.

(*Furvus*, blackish-brown; *caudatus*, tailed.)

Subgenus GENYOROGE Cantor.

Genyoroge Cantor, Journ. As. Soc. Bengal (Cat. Malay. Fish.), XVIII, 1850, p. 12 (*sebæ*).

132. Lutianus chirtah (Cuvier).

133. LUTIANUS MALABARICUS (Schneider).
134. LUTIANUS SEBÆ (Cuvier).

ETELINÆ.

135. APRION TYPUS (Bleeker).

DENTICINÆ.

ANEMURA subgen. nov.

Type *Dentex notatus* Day.

Six canines in upper jaw. First dorsal spine without filament. No filament to upper caudal lobe.

('A, without; νῆμα, thread; οὐρὰ, tail.)

136. DENTEX NOTATUS Day.

ODONTOGLYPHIS subgen. nov.

Type *Dentex tolu* Valenciennes.

Three series of large scales on cheek. Margin of spinous dorsal deeply notched, so that ends of spines are free for good part of their length. Teeth equal, except two canines in front of upper jaw.

('Οδοντογλῠφὶς, tooth-pick; relating to free ends of dorsal spines.)

137. DENTEX TOLU Valenciennes.

EUTHYOPTEROMA subgen. nov.

Type *Dentex blochii* Bleeker.

Scales large on cheek. Margin of spinous dorsal straight, unnotched. Canines only in front of upper jaw.

(Εὐθὺς, straight; πτέρωμα, fin; referring to entire margin of spinous dorsal.)

138. DENTEX BLOCHII Bleeker.
139. DENTEX MESOPRION Bleeker.
140. GYMNOCRANIUS LETHRINOIDES (Bleeker).

THERAPONIDÆ.

Subgenus THERAPON Cuvier.

Therapon Cuvier, Hist. Nat. Poiss., III, 1829, p. 94 (*servus*).

Scales small, 75 to 100 in a lateral series to base of caudal.

141. THERAPON JARBUA (Forskål).

EUTHERAPON subgen. nov.

Type *Therapon theraps* Cuvier.

Scales large, about 55 in a lateral series.

(Εὖ, properly; θεράπων, a servant or slave.)

142. THERAPON THERAPS Cuvier.

HÆMULIDÆ.

EUELATICHTHYS subgen. nov.

Type *Diagramma affine* Günther.

About 45 scales in a lateral series to base of caudal. Body deep. Dorsal spines 12 or more.

(Εὐήλᾰτος, well beaten out or hammered; ἰχθὺς, fish.)

143. PLECTORHINCHUS AFFINIS (Günther).

SPILOTICHTHYS subgen. nov.
Type *Holocentrus radjabau* Lacépède.

Dorsal spines 10. Scales small.
(Σπιλωτὸς, stained or blotched; ἰχθὺς, fish.)

144. PLECTORHINCHUS RADJABAU (Lacépède).

Subgenus PLECTORHINCHUS (Lacépède).

Dorsal with 11 to 13 spines. Scales small, about 80.

145. PLECTORHINCHUS SEBAE (Bleeker).
146. POMADASYS COMMERSONNII (Lacépède).
147. SCOLOPSIS BLEEKERI Günther.
148. ODONTONECTES ERYTHROGASTER (Cuvier).
149. CÆSIO CÆRULAUREUS Lacépède.
150. CÆSIO ERYTHROCHILURUS sp. nov. Plate XIX, upper figure.

Head 3; depth $2\frac{3}{4}$; D. X, 15; A. III, 11; P. II, 17; V. I, 5; scales 52 in a lateral series to base of caudal below lateral line; 8 scales between origin of spinous dorsal and lateral line, and 15 between latter and origin of anal; 52 scales in lateral line to base of caudal; width of head $2\frac{1}{10}$ in its length, measured from tip of upper jaw; depth of head $1\frac{1}{4}$; snout 4; eye $3\frac{2}{3}$; maxillary 3; interorbital space $3\frac{3}{7}$; mandible $2\frac{1}{2}$ in head, measured from its own tip; third dorsal spine $2\frac{1}{6}$; first dorsal ray $2\frac{3}{4}$; third anal spine 3; first anal ray $2\frac{2}{3}$; least depth of caudal peduncle $3\frac{1}{10}$; ventral $1\frac{2}{3}$.

Body elongate, compressed, more or less ellipsoid, back little if any elevated, and profiles more or less evenly convex. Caudal peduncle compressed, and its least depth about three-fourths its length.

Head rhomboid, rather deep, compressed, and upper profile slightly concave over front of eye. Snout short, somewhat broad, convex, and upper jaw but little projecting. Eye moderate in size, orbicular, a little high, and its posterior margin about midway in length of head. Mouth well inclined, and when closed mandible protrudes a little beyond upper jaw. Maxillary reaching a little beyond front rim of orbit, and its distal expanded extremity two-fifths latter's diameter. Preorbital narrow, its least width one-fourth of orbit. Teeth minute, several a little enlarged and canine-like in front of upper jaw. Each ramus well elevated inside mouth. A series of minute teeth on vomer and along each palatine. Tongue elongate, pointed, and free in front. Nostrils close together, well separated from upper front rim of orbit. Anterior nostril with a slight cutaneous rim. Interorbital space convexly elevated. Margin of preopercle finely serrate, and suprascapula smooth along its margin. An obsolete opercular spine, and a pointed opercular flap behind.

Gill-opening extending forward opposite front rim of orbit. Gill-rakers 11 + 23, long, slender, and pointed, equal to longest filaments, which are half of orbit. Pseudobranchiæ as large as gill-filaments. Isthmus narrow and convex.

Scales moderately large, ctenoid, running in series parallel with lateral line above its course, and in more or less horizontal longitudinal series below. Interorbital space, snout, narrow orbital border, preorbital, maxilliary and jaws naked, head otherwise scaly. A patch of scales on top completely crossing over inter-

orbital area above. Four series of scales on cheek. Basal portions of vertical fins all with reduced and crowded scales, on caudal they become minute and extend well over lobes. Bases of pectoral and ventral more or less with minute scales. Lateral line a little convex, somewhat concurrent with dorsal profile, approaching it more closely posteriorly, running a little high on side of caudal peduncle and well out on base of caudal. A long pointed scaly flap at base of ventral.

Origin of spinous dorsal behind that of pectoral, spines slender, first shortest, five or six immediately following highest, and others graduated to last, which is shorter than any excepting first. Margin of fin hardly notched. Origin of soft dorsal over tip of pectoral, anterior rays longest, and margin of fin a little convex behind. Anal inserted a little behind origin of soft dorsal, spines slender, first very short, and second and third about equal. Soft anal graduated from first rays, which are longest, and margin of fin nearly straight. Caudal deeply forked, lobes slender, pointed, and upper longer. Pectoral long and a number of upper rays long. Ventral inserted behind origin of pectoral, pointed, and spine about two-thirds length of fin. Anus nearer tip of ventral than origin of anal.

Color in arrack rich olivaceous-brown above, more or less washed with golden-green, middle rays of each caudal lobe yellowish-green. Lower surface of body, together with lower side of trunk, head and caudal peduncle, deep rosy. Edges of caudal lobes, and several of middle rays, paler rosy. Dorsal fin olivaceous-brown, margin or border broadly blackish. Ventral and anal orange, former inclining to deep red. Pectoral deep orange, with axil and a distinct blotch at base of upper rays jet-black. Peritoneum silvery.

Length $5\frac{3}{4}$ inches.

Type No. 27,621, A. N. S. P. Padang.

Nineteen examples. Closely related to *Cæsio lunaris* Ehrenberg as identified by Bleeker's East Indian examples. It agrees with it more or less in the large scales, fin radii, and deep body. *C. lunaris* has fewer scales in a vertical series above the lateral line, and a differently colored caudal, the tip of each lobe black.

('Ερυθραῖος, red; χεῖλος, margin; οὐρὰ, tail.)

SPARIDÆ.

Subgenus LETHRINUS Cuvier.

151. Lethrinus ornatus Valenciennes.
152. Lethrinus opercularis Valenciennes.

LETHRINELLA subgen. nov.

Type *Sparus miniatus* Schneider.

Snout long and pointed. Lips broad and fleshy, upper equal to diameter of pupil. Conic pointed teeth.

(" Le nom que nous avons cru pouvoir donner à ce genre est celui que la pagel porte en grec moderne " [Valenciennes].)

153. Lethrinus miniatus (Schneider).

SCIÆNIDÆ.

154. Otolithus argenteus Cuvier.
155. Sciæna macroptera (Bleeker).

POLYNEMIDÆ.

156. Polydactylus pfeifferi (Bleeker). Plate XVI, lower figure.

GERRIDÆ.

PERTICA subgen. nov.

Type *Gerres filamentosus* Cuvier.

Second dorsal spine longer than head.

(*Pertica*, a pole; with reference to second dorsal spine.)

157. Gerres filamentosus Cuvier.

KYPHOSIDÆ.

158. Kyphosus lembus (Cuvier).

MULLIDÆ.

159. Upeneoides sulfureus (Cuvier).
160. Upeneoides moluccensis Bleeker.
161. Upeneus malabaricus Cuvier.

NANDIDÆ.

162. Pharopteryx corallicola (Bleeker).

OSPHRONEMIDÆ.

163. Osphronemus goramy Lacépède.
164. Trichopodus trichopterus (Pallas).

ANABANTIDÆ.

165. Anabas scandens (Daldorff).

OPHICEPHALIDÆ.

166. Ophicephalus spiritalis sp. nov. Plate IX, lower figure.

Head 3; depth $5\frac{1}{4}$; D. 39; A. 28; P. I, 16; V. I, 5; 55 scales to base of caudal in a lateral series; about 16 osseous scales before dorsal; 5 scales between origin of dorsal and lateral line, and 11 between latter and origin of ventral; width of head 2 in its length; depth of head $2\frac{1}{10}$; snout $5\frac{3}{4}$; eye $7\frac{1}{8}$; mouth, from tip of snout, $3\frac{1}{5}$; maxillary $2\frac{4}{5}$; mandible $2\frac{1}{20}$; interorbital space $4\frac{1}{2}$; pectoral 2; ventral $2\frac{5}{6}$; caudal $1\frac{3}{4}$; least depth of caudal peduncle $2\frac{3}{4}$.

Body moderately elongate, rather thick, greatest depth about outer portion of ventral. Tail long, rather deep and compressed.

Head large, elongate, broad, depressed in front, and sides rounded with a swollen appearance. Snout short, broad, rounded when viewed above. Eye small, superior, and its posterior rim about first third in length of head. Mouth large, broad, oblique, and maxillary reaching below posterior portion of orbit. It is received in a deep infraorbital groove, and its distal extremity dilated till about three-fifths of eye-diameter. Mandible large, flattened below, and projecting well beyond tip of snout. Teeth in upper jaw minute, and in a broad band. Mandible with a small short patch of similar teeth at symphysis in front, and along sides a single series of enlarged, compressed, rather short and sharp pointed teeth. An outer series of small irregular pointed teeth along outer bases of enlarged teeth, in

jaws. Vomer with a long fang in center, and several small teeth about. Palatines with a single series of a few enlarged teeth, similar to those along sides of mandible. Tongue rather long, narrow and free. Lips rather broad and somewhat fleshy. Anterior nostril with a short bifid tube. Posterior rather large, circular, level with upper rim and nearly opposite front rim of orbit. Interorbital space broad and flattened. Opercle with a narrow fleshy gill-flap. Top of head broad and more or less flattened, becoming convex posteriorly.

Gill-opening large, extending forward till about an eye-diameter posterior to posterior rim of orbit, and branchiostegal membrane forming a broad fold over isthmus. Gill-rakers small, short broad asperous stumps, and 7 in number on first arch. Gill-filaments short. Accessory branchial cavity large, and with a large fleshy valve.

Scales moderately large, cycloid, those on bases of caudal and pectoral fins small. On head above, and opercular region, scales become bony and firmly joined to top of head. Lateral line slightly oblique at first, then dropping down a scale over third anal ray and extending straight to base of caudal.

Dorsal fin of nearly uniform height, long, and beginning over posterior margin of gill-opening. Anal beginning about midway between tip of snout and base of caudal, similar to dorsal in size and shape. Caudal oblong, its posterior margin convex. Pectoral rounded, middle rays longest. Ventrals small, inserted well behind pectorals, and reaching anus. Caudal peduncle deep and compressed.

Color in arrack more or less brown, dark or dusky above, and lower surface whitish or soiled-brown. Trunk more or less mottled or blotched with blackish-brown. A pale streak along side from opercle, and below this four or five large blackish blotches. Opercle with a blackish blotch. A dark streak from eye above obliquely across opercle, and another similar one from lower margin of eye. Fins all more or less dusky, with obliquely horizontal blackish lines on dorsal and anal in front, becoming more or less parallel with fin posteriorly. Caudal with indistinct blackish mottlings. Pectoral with four or five vertical cross-bars of blackish. Ventrals mottled with dusky. Peritoneum silvery.

Length $11\frac{1}{8}$ inches.

Type No. 27,664, A. N. S. P. Padang.

One example. This species is close to *Ophicephalus pleurophthalmus* Bleeker,[1] differing however in color. Sides without the large ocelli of that species, but about six large dark blotches below lateral line, like those in Bleeker's figure of *O. lucius*.[2] Pectoral barred, in this case agreeing with *O. polylepis* Bleeker,[3] but that species is said to have longitudinal dark bands or lines on dorsal and anal, and sides without dark blotches. *O. urophthalmus* Bleeker[4] is probably the same as *O. pleurophthalmus* from Borneo.

(*Spiritalis*, belonging to air or breath. Applied as *Ophicephalus* is said to live in mud-pools and rise to the surface before it becomes sun-baked to take in air at times.)

[1] Nat. Tijds. Ned. Ind., I, 1850, p. 270.
[2] Atlas Ichth., VIII, 1877, plate 398 (2), fig. 1.
[3] Nat. Tijds. Ned. Ind., III, 1852, p. 578.
[4] L. c.

POMACENTRIDÆ.

167. PREMNAS EPIGRAMMATA sp. nov. Plate XIX, lower figure to right.

Head $3\frac{1}{3}$; depth 2; D. X, 16; A. II, 14; P. I, 15; V. I, 5; scales 66 in a lateral series below lateral line to base of caudal; 44 porous scales in lateral line to base of caudal; 10 scales in an oblique series from origin of spinous dorsal back to lateral line, and 25 between latter forward to origin of anal; width of head $1\frac{1}{2}$ in its length; depth of head over posterior margin of eye 1; snout 3; eye $4\frac{1}{2}$; maxillary 3; interorbital space $3\frac{1}{2}$; first dorsal spine $2\frac{1}{4}$; second anal spine $2\frac{1}{4}$; least depth of caudal peduncle $1\frac{4}{5}$; caudal 1; pectoral 1; ventral $1\frac{1}{5}$.

Body ellipsoid, deep, and strongly compressed, profiles similar. Caudal peduncle compressed, rather deep, and its length about three-fifths its least depth.

Head deep, protruding, and its anterior profile evenly though strongly convex. Upper profile from above eye to origin of spinous dorsal a little concave. Snout broad, blunt, with a convex surface and profile, and upper jaw slightly projecting. Eye small, high, anterior and circular. Mouth broad, short, and gape reaching opposite posterior nostril. Maxillary narrow, its width about equal to pupil of eye and its posterior margin reaching opposite front rim of orbit. Mandible broad, rami short and even with upper jaw in front. Teeth compressed, uniserial and with their extremities more or less truncate. Vomer and palatines edentulous. Tongue far back, broad, rather blunt and little free in front. Nostrils near together, small, circular, posterior nearer anterior than front of eye. Interorbital space broad, and a little convex or not much elevated. Bony orbital rim narrow, corrugated, or roughly striated, preorbital with a short spine directed downward, and infraorbital ending in a backwardly directed spine that reaches about middle of opercle. Margin of preopercle with a number of rough jagged denticles. Opercle finely striate. Subopercle coarsely striate and with its margin denticulate.

Gill-opening extending forward about opposite posterior margin of pupil, and membrane forming a rather narrow free fold across. Gill-rakers 6 + 13, short, pointed, rather weak, and equal to about two-thirds of longest filaments. Gill-filaments about five-sixths of orbit. Pseudobranchiæ well developed, a little over half of orbit. Isthmus compressed, narrow and with a shallow groove in front.

Scales mostly finely ctenoid and small. Head more or less naked, cheek, interopercle, and upper moiety of pectoral covered with small scales. A broad naked space on each side of head above between eyes and interorbital space, and occiput. Bases of vertical fins covered with minute scales. Bases of pectoral and ventral with minute scales, and space between bases of ventrals thickly scaled. Lateral line well curved up, ending about opposite last two-thirds of base of soft dorsal. Tubes simple.

Spinous dorsal inserted a little before origin of pectoral, fourth spine longest, others graduated from it, and first and sixth of about even length. Soft dorsal inserted a little before tip of pectoral, posterior rays highest, much higher than posterior dorsal spines, and forming a blunt lobe. Anal inserted about opposite origin of soft dorsal, first spine short, and rays of soft fin more or less equal in

height, forming a blunt lobe posteriorly. Caudal rounded. Pectoral similar to caudal, rounded, and median rays longest. Ventral inserted well behind pectoral, innermost ray united with abdomen by a membrane for greater part of its length, rounded, and when depressed reaching origin of soft anal. Ventral spine straight, a trifle longer than half length of fin. Anus about midway between tip of ventral spine and origin of anal fin.

Color in arrack deep clove-brown, paler beneath, and fins also more dilute distally. A broad milky-white saddle, slightly tinted with pearl-gray, extending from occiput and just behind eye till down on middle of opercle. There it gives place to a brownish-black line extending down across interopercle. A similar narrower saddle extends down on back to middle of abdomen from ninth and tenth dorsal spines. This is also continued below to origin of spinous anal as a blackish-brown line. Caudal peduncle with a similar saddle-like band, becoming narrower below. Blackish-brown lines of two preceding saddles extends up narrowly along their edges, forming a dark border. Saddle on caudal peduncle also with similar dark edges. Iris with a yellow ring, otherwise dusky-slate color. Peritoneum grayish-silvery.

Length $3\frac{13}{16}$ inches.

Type No. 27,665, A. N. S. P. Padang.

Two examples. Bleeker recognized three varieties of *Premnas biaculeatus*. According to his diagnosis this species approaches near *semicincta* of Cuvier,[1] but both the original figure and that by Bleeker[2] do not agree, as no dark lines are indicated running down from the saddles above. Furthermore, the saddles are of altogether different pattern. They do not extend as low, the second blotch hardly extends on spinous dorsal, and last does not entirely encircle caudal peduncle.

(*Epigramma*, brand.)

Subgenus AMPHIPRION Schneider.

168. AMPHIPRION EPHIPPIUM (Bloch).

ACTINICOLA subgen. nov.

Type *Lutjanus percula* Lacépède.

Dorsal deeply notched, though spinous and rayed fins are connected they are also distinct.

(*Actinia*, Sea-anemone; *incola*, inhabitant. According to Day the following species is commensal in certain *Actinizoa*.)

169. AMPHIPRION PERCULA (Lacépède).
170. DASCYLLUS ARUANUS (Linnæus).
171. DASCYLLUS TRIMACULATUS (Rüppell).
172. CHROMIS CINERASCENS Cuvier.
173. POMACENTRUS LEUCOSPHYRUS sp. nov. Plate XIX, lower figure to left.

Head $3\frac{2}{5}$; depth $2\frac{2}{3}$; D. XIII, 11; A. II, 11; P. II, 14; V. I, 5; scales 28 in a lateral series below lateral line to base of caudal; 3 scales between origin of spin-

[1] Hist. Nat. Poiss., V, 1830, p. 307, plate 133, fig. 1.
[2] Atlas Ichth., IX, 1878, plate 402 (3), fig. 7.

ous dorsal and lateral line; 11 scales in an oblique series up to lateral line from origin of anal; 16 scales in lateral line; width of head 2 in its length; depth of head, over middle of orbit, $1\frac{1}{8}$; snout 4; eye $3\frac{2}{3}$; maxillary $3\frac{1}{6}$; interorbital space 3; last dorsal spine $1\frac{1}{2}$; second anal spine $1\frac{2}{5}$; least depth of caudal peduncle 2; pectoral 1.

Body elongate, compressed, greatest depth at origin of ventral, and upper profile a little more convex in front. Caudal peduncle compressed, and its depth equal to its length.

Head small, deep, and upper profile evenly though slightly convex from upper jaw to occiput. Snout short, broad and convex, upper jaw projecting a little. Eye small, a little above middle of depth of head, circular, and its posterior margin a trifle before middle in its length. Mouth small, oblique, mandible slightly protruding beyond upper jaw, distal expanded end of maxillary about two-fifths of orbit, and reaching a little beyond its front rim. Teeth uniserial, compressed, with truncate extremities, and forming cutting edges in jaws. Vomer and palatines edentulous. Tongue rather elongate, narrow, pointed, free and moderately far back in mouth. Nostril circular, midway on side of snout. A small pore close in front. Interorbital space a little broader than eye and convex. Preopercle with minute irregular or jagged edge. Opercle with two short spines, one at angle most pronounced.

Gill-opening extending forward opposite front rim of orbit. Gill-rakers 7 + 17, slender, elongate, a little shorter than filaments, which are about two-thirds of orbit. Pseudobranchiæ about half of orbit. Isthmus narrow, compressed, its edge a little flattened, and membrane forming a short fold across.

Scales large, finely ctenoid, broadly exposed, and largest on middle of side. Smaller scales crowded along bases of vertical fins, and still smaller or minute scales extending well out between spines and rays. Along bases of spinous dorsal and anal a line of demarcation, indicating profile of trunk, evident. Base of pectoral with minute scales. Small scales crowded on snout, interorbital space, top of head, and around eye. Four rows of scales on cheek. Lateral line convex, slightly recurved near its termination below bases of third or fourth dorsal rays. Below and a little above middle a series of ten scales, each with a puncture, continue to base of caudal. Tubes of lateral line simple. At beginning of lateral line a large scale thickly covered with small scales.

Spinous dorsal inserted well in advance of origin of pectoral, margin of fin notched with a cutaneous flap behind tip of each spine, and spines more or less graduated to last, which is longest. Soft dorsal inserted nearly midway between middle of pectoral and base of caudal, rays graduated to sixth, which is longest, and prolonged into a filamentous point reaching about three-fifths length of caudal. Anal inserted about opposite eleventh dorsal spine, second spine a little more than twice length of first, or about equal to half of eye and postocular region. Soft anal similar to soft dorsal, larger, and seventh ray longest, not quite reaching middle of caudal. Posterior rays of both fins much shorter than anterior. Caudal deeply

forked, and lobes long, slender, and ending in slender or narrow points. Pectoral small, not reaching origin of anal, and rather broad. Ventral inserted a little behind pectoral, and first ray longest, extending to origin of anal fin. Ventral spine slender and reaching about half of distance.

Color in arrack black with a dull violaceous tinge. Each scale with a dusky or slightly olivaceous margin, more distinct than basal portion, which has a dull slaty tint. Fins all blackish, pectoral paler, and first ray of ventral beyond spine pearly-white. Pronounced scale at beginning of lateral line black, forming a distinct blotch. Iris slaty.

Length $4\frac{3}{8}$ inches.

Type No. 27,673, A. N. S. P. Padang.

One example. This species is closely related to *Pomacentrus violascens* (Bleeker). It differs however in the almost uniform dark color, without any yellow or golden on lower regions or caudal peduncle. Ventrals also differ, as they are entirely dark like the other fins, except tip of first or longest ray which is pearl-white beyond tip of spine.

(Λευκόσφῦρος, white-footed, with reference to the white-tipped ventrals.)

174. Pomacentrus tripunctatus Cuvier.
175. Pomacentrus vanicolensis Cuvier.
176. Chrysiptera modesta (Schlegel and Müller).
177. Chrysiptera unimaculata (Cuvier).
178. Glyphisodon septemfasciatus Cuvier.
179. Glyphisodon saxatilis (Linnæus).
180. Glyphisodon leucogaster Bleeker.

LABRIDÆ.

181. Choerops schoenleinii (Valenciennes).
182. Lepidaplois mesothorax (Schneider).
183. Stethojulis phekadopleura (Bleeker).

OCTOCYNODON subgen. nov.

Type *Julis miniatus* Valenciennes.

Canines $\frac{4}{4}$.

('Οκτὼ, eight; κύων, dog; ὀδοὺς, tooth.)

184. Halichœres miniatus (Valenciennes).
185. Halichœres annulatus sp. nov. Plate XX, upper figure.

Head $2\frac{9}{10}$; depth $3\frac{1}{2}$; D. IX, 11; A. III, 11; P. II, 11; V. I, 5; scales 28 in a lateral series below lateral line to base of caudal; 2 scales between anterior spinous dorsal and lateral line; 28 scales in lateral line, last one on base of caudal; 8 scales obliquely back and up to lateral line from origin of anal; width of head $2\frac{1}{2}$ in its length; depth of head over middle of eye $1\frac{2}{3}$; snout 3; eye $5\frac{1}{5}$; mouth $3\frac{1}{3}$; interorbital space $4\frac{3}{5}$; first dorsal spine $4\frac{3}{4}$; ninth $3\frac{1}{5}$; first dorsal ray $2\frac{1}{2}$; third anal spine $3\frac{1}{8}$; first anal ray $2\frac{1}{3}$; caudal $1\frac{1}{2}$; least depth of caudal peduncle $2\frac{1}{5}$; pectoral $1\frac{4}{7}$; ventral $1\frac{4}{5}$.

Body elongate, compressed, upper profile a little more convex, and greatest

depth about front of spinous dorsal. Caudal peduncle deep, compressed, and its length about four-fifths of least depth.

Head elongate, pointed, compressed, and profiles similar though upper a little more oblique. Snout long, convex above, and lip protruding in front. Eye small, with horizontal diameter a trifle longer, high, and its posterior margin near middle of head. Mouth small, horizontal, jaws equal, and corner extending about opposite posterior nostril. Preorbital broad, concealing end of maxillary. Lips broad, fleshy, and with their inner surfaces plicate. Teeth conic, pointed, uniserial, and with four canines in front of each jaw. Each side of upper jaw posteriorly with a canine. Tongue a little broad, rounded, free in front, and depressed or flattened above. Nostrils well separated, near upper margin of eye anteriorly, and anterior with a small cutaneous rim. Interorbital space elevated a little convexly. Opercle with a rather large cutaneous flap.

Gill-opening extending forward about opposite posterior margin of orbit. Gill-rakers 7 + 9 ? short weak points. Filaments less than eye and pseudobranchiæ much smaller. Isthmus broad and membrane forming but a narrow fold across.

Scales rather large, cycloid, becoming smaller on occiput, chest, at base of pectoral and on basal portion of caudal. Fins and head otherwise without scales. Lateral line concurrent with dorsal profile till below last dorsal rays, then sloping down and extending along middle of side of caudal peduncle to base of caudal. Tubes mostly with one or two bifurcations.

Origin of spinous dorsal about opposite that of pectoral, spines pungent, more or less graduated to the last which is longest, and margin of fin entire. Soft dorsal a little higher, origin of fin a little nearer eye than base of caudal, edge entire, and anterior rays longest. Origin of spinous anal about opposite origin of soft dorsal, spines pungent and third longest. Anterior anal rays longest, and membrane along margin of fin entire. Caudal with a convex margin when expanded, and edges of fin rounded. Pectoral broad, upper rays longest and not reaching opposite anus. Ventral inserted nearly opposite origin of pectoral, pointed, first ray longest, and not reaching tip of pectoral. Ventral spine slender, pungent, and nearly equal to three-fifths length of fin. Anus nearly midway between tip of ventral and origin of anal fin.

Color in arrack pale brownish-white, fins a little lighter than trunk. Five large deep brownish-dusky blotches along upper side of back. A broad brown band from opercular flap to base of caudal, more or less unevenly margined above and below with spots or flakes of pearly, and marked also with six large deep blackish or dusky-brown blotches, third and fourth of which are more or less confluent, not only with themselves but also with those on back above. Almost all of scales, especially those of darker hue, marked with paler centers. Pearly flakes or streaks on lower surface of body pronounced. Top of head with bluish streaks or short blotches. A bluish streak extends down from upper side of head towards eye. A broad bluish band from eye to corner of mouth, another below first toward lower margin of eye, another broader back across opercle then down to edge of gill-open-

ing, and finally a broad blue ring on cheek including margin of preopercle. Opercular flap with a broad blue-black blotch. All of markings on head narrowly margined with dark brownish. Vertical fins with blotches of pale pearly-bluish. Along base of dorsal these form large distinct blotches more or less rounded, enlarged and most pronounced on soft dorsal. On soft dorsal about second and third rays a large blackish blotch, and extending around paler blotches. Upper portions of dorsals also marked with similar large pale or pearly-blue blotches, most distinct on rayed fins. Anal with a basal series of pearly spots, one on membrane between each ray, a broad median pearly band longitudinally, and margin of fin a little dusky. Caudal with about five pale spots, with slightly brownish margins on each ray forming as many vertical series, and most distinct on outer median portion, which is also a trifle dusky. Pectoral and ventral unmarked. Peritoneum silvery-gray.

Length $3\frac{7}{8}$ inches.

Type No. 27,713, A. N. S. P. Padang.

Close to *Halichœres poecila* (Lay and Bennett) from near Riu Kiu. This was identified with *Julis* (*Halichœres*) *harloffii* Bleeker by that distinguished naturalist. However, he apparently had two forms united under *harloffii*, one of which represents the examples before me. *Harloffii* is figured later, though the description applies to *annulatus*. The complete circle or ring on the lower side of the head is the chief character for the distinction of *annulatus*.

(*Annulatus*, ringed.)

Subgenus HALICHŒRES Rüppell.

Canines $\frac{2}{2}$.

186. Halichœres nigrescens (Schneider).
187. Halichœres leparensis (Bleeker).
188. Halichœres hartzfeldii (Bleeker).
189. Halichœres guttatus (Bloch).
190. Thalassoma lunare (Linnæus). Plate XXIII, lower figure.
191. Thalassoma melanochir sp. nov. Plate XX, middle figure.

Head $2\frac{5}{6}$; depth $3\frac{1}{4}$; D. VIII, 13; A. III, 11; P. II, 14; V. I, 5; scales 24 in a lateral series below lateral line to base of caudal; 3 scales between lateral line and origin of spinous dorsal; 8 scales between origin of anal obliquely back to lateral line; 26 scales in lateral line, last one on base of caudal; width of head $2\frac{2}{5}$ in its length; depth of head over anterior margin of eye $1\frac{2}{3}$; snout $2\frac{1}{2}$; eye $6\frac{3}{4}$; mouth $3\frac{2}{3}$; interorbital space $4\frac{1}{4}$; eighth dorsal spine $3\frac{7}{8}$; second dorsal ray $2\frac{7}{8}$; third anal spine $4\frac{1}{2}$; second anal ray $3\frac{1}{8}$; least depth of caudal peduncle $2\frac{4}{7}$; caudal, measured to tip of middle rays, $1\frac{7}{10}$; pectoral $1\frac{2}{5}$; ventral $2\frac{2}{5}$.

Body elongate, compressed, deepest anteriorly or about origin of ventral, and upper profile a little more convex than lower. Caudal peduncle compressed, and its least depth a trifle less than its length.

Head moderately large, compressed, pointed, and its upper profile evenly convex from tip of upper jaw to occiput. Snout long, compressed, sides flattened, its upper surface convex, and upper jaw well protruded in front. Eye small, circular,

high, and its posterior margin midway in length of head. Mouth small, slightly inclined, jaws equal, and free edge of preorbital nearly opposite anterior nostril. Lips large, fleshy, and with inner surfaces plicate. Teeth uniserial, conic, and with two canines in front of each jaw. Tongue broad, rounded, and entirely free in front. Nostrils well separated, rather high and posterior on side of snout near upper front of eye, small, and anterior in a small cutaneous tube. Interorbital space broad, convex, and equal to a little more than one and one-half eye-diameters. Opercular flap a little long and pointed.

Gill-opening extending till within a little posterior to eye. Gill-rakers 5 + 16, small, short, compressed, and broadly triangular rudiments. Gill-filaments much larger, almost equal to eye-diameter in length. Pseudobranchiæ smaller. Isthmus broad, and membrane forming but a narrow fold across.

Scales large, cycloid, and crowded along bases of vertical fins. On bases of soft dorsal and anal pointed, not forming a basal sheath, and on base of caudal becoming small, especially on upper and lower elongated rays. A small patch of scales on opercular region above, head otherwise naked. Two short pointed scales at axillary region of ventral, and a single broad one between bases of two fins. A large scale above opercular flap at shoulder girdle. Lateral line concurrent with dorsal profile, sloping down below last rays of dorsal and continued along side of caudal peduncle medianly to base of caudal. Tubes arborescent.

Origin of spinous dorsal a little before that of pectoral, spines pungent, last highest, and margin of fin entire. Soft dorsal inserted a little before tip of pectoral or a little nearer base of caudal than posterior margin of eye, anterior part of fin highest, and its posterior extremity rounded. Anal inserted about opposite base of third dorsal ray or beyond tip of pectoral, spines small, pungent, and third longest. Soft anal similar to soft dorsal. Caudal truncate medianly, upper and lower rays produced in short points, and when expanded median rays form a convex margin. Pectoral rather long, upper rays longest, tip of fin rounded, and its posterior margin obliquely straight. Ventral small, inserted well behind pectoral, broad, pointed, reaching a little over half way to anal, and small pungent spine about three-fifths length of fin.

Color in arrack olive-green above, lower surface of head, abdomen, and caudal peduncle sky-blue white. Three broad deep purplish bands radiating from below and behind eye, last extending across opercle to front of pectoral. Another broad band extends along each side of snout to eye, and still another includes interorbital space to eye and extends back along upper side of head to gill-opening. All of bands on head narrowly margined with dusky-bluish. About seven jet-black transverse bars along side of back. First continued from supracephalic band of purple along upper shoulder girdle and down in front of base of pectoral, also a little below. Second similarly oblique, and extending down on side of abdomen as far as first. Several of scales between these two bands with centers largely black. Remaining transverse bars all wedge-shaped, becoming narrow below, and smaller posteriorly. A purplish longitudinal band along back above, parallel with first part of lateral

line, then extending along upper edge of caudal peduncle and out on uppermost caudal rays, where it becomes reddish. From lower portion of third transverse black blotch, a broad salmon-red horizontal band longitudinally and medianly to base of caudal. A similar streak of pinkish hue along lower edge of caudal peduncle forward. Dorsal pale yellow, with a median longitudinal band of dusky, broad at first, and narrowing down and fading out on last dorsal rays. Anal whitish, with a dusky blotch on first three rays. Caudal with its posterior portion broadly dusky-gray. Pectoral pale, creamy at base, with a black axillary spot at its base above, and terminal portion broadly black. Ventral dilute yellowish.

Length $6\frac{3}{8}$ inches.

Type No. 27,724, A. N. S. P. Padang.

One example. Closely related to *Thalassoma hardwicke* (Bennett).[1] It differs in blackish-tipped pectoral and presence of an oblique black band before base of pectoral. Bleeker's figure agrees with *melanochir*, except that he does not show the pectoral with a blackish extremity. *Thalassoma dorsale* (Quoy and Gaimard) has been identified with *hardwicke*, though it does not appear to have a broad rosy lateral band extending along side of trunk to caudal peduncle. *Julis semifasciatus* Valenciennes may also be allied or identical with *dorsale*, and the same may be said of *Julis* (*Julis*) *urostigma* Bleeker.

(Μέλας, black; χεὶρ, hand.)

192. CHEILINUS TRILOBATUS Lacépède.
193. CHEILINUS ENNEACANTHUS (Lacépède).
194. CHEILINUS DIAGRAMMA (Lacépède).
195. HEMIPTERONOTUS LIOGENYS sp. nov. Plate XX, lower figure.

Head $3\frac{1}{4}$; depth $2\frac{3}{4}$; D. II, VII, 12; A. II, 12; P. II, 10; V. I, 5; 26 scales below lateral line to base of caudal; 2 scales between origin of second spinous dorsal and lateral line; 9 scales obliquely back from origin of anal to lateral line; 21 scales in first division of lateral line, and 6 more in remaining portion with last scales on base of caudal; width of head $2\frac{1}{2}$ in its length; depth of head, over anterior margin of eye, equal to its length; first flexible spine of dorsal about $2\frac{2}{5}$; fifth pungent spine $3\frac{3}{4}$; fifth dorsal ray 3; second anal spine $5\frac{1}{2}$; third anal ray $2\frac{1}{5}$; least depth of caudal peduncle $2\frac{3}{5}$; caudal $1\frac{1}{2}$; pectoral $1\frac{2}{7}$; ventral $1\frac{1}{2}$; snout $1\frac{3}{4}$; eye $5\frac{3}{4}$; mouth $3\frac{3}{5}$; interorbital space 5.

Body oblong-elongate, greatly compressed, slightly trenchant, and profiles of trunk more or less similar. Greatest depth at base of ventral, and from that point posteriorly body becoming gradually less in depth to caudal peduncle. Caudal peduncle deep, compressed, and its length a little less than its depth.

Head deep, greatly compressed, large, parabolic, upper profile steep, convex from level with eye to origin of dorsal, and somewhat trenchant. Snout long, compressed, a little trenchant, and its profile nearly straight from opposite eye to tip of

[1] This name apparently has priority over *dorsale* of Quoy and Gaimard, though I have not been able to consult the original edition of the work as it is not contained in the Academy's library at present. It was published in London by Longman & Co., 1828 to 1839. The copy of the second edition now before me is by Edward Bull, Holles Street, Cavendish Square. It has a prefatory account which is dated "London, March 1, 1830."

snout. Eye small, high, circular, and nearly midway in head. Mouth low, moderately large, and corner falling about opposite anterior nostril. Jaws large, broad, not much produced, though forming a blunt angle at lower anterior profile. Lips broad, especially lower, thick and fleshy. Teeth uniserial, strong, conic, and front of each jaw with two large curved exposed canines, lower pair fitting in between upper and directed a little laterally. Tongue small, well back in mouth, and a little free in front. Nostrils minute and high. Interorbital space convex, elevated, and a little trenchant in middle. Margins of preopercle and gill-opening thin, former rounded.

Gill-opening extending forward till opposite front rim of pupil. Gill-rakers 5 + 8, short, uneven, and with small pricks on their inner surfaces. Gill-filaments much longer, equal to at least three-quarters of eye-diameter. Pseudobranchiæ smaller. Isthmus narrow, compressed, and membrane forming a rather broad fold across.

Scales large, thin, cycloid, and with exposed portions narrow. Fins naked, except base of caudal which is closely scaled, but none of its scales enlarged. Head naked, except occiput, a few scales on opercle above, and a few below and behind eye. Lateral line convex at first and then more or less straight till below posterior dorsal rays where it drops suddenly to middle of side of caudal peduncle, continuing straight and medianly to base of caudal. Tubes mostly simple, sometimes bifid.

Dorsal beginning close behind eye, first two spines flexible, and membrane uniting them with succeeding deeply incised. Other dorsal spines pungent, of nearly uniform height, and margin of fin straight. Soft dorsal inserted nearly midway between posterior end of maxillary and base of caudal, rays of about uniform height, and most of them higher than pungent spines. Anal inserted a trifle in advance of soft dorsal, spines small, pungent, second longest, and rayed fin similar to soft dorsal. Caudal rather small and rounded. Pectoral long, broad, upper rays pointed, and reaching below base of last pungent dorsal spine. Ventral long, pointed, inserted below origin of pectoral, spine short, and a little less than a third in length of fin. When depressed fin reaches nearly three-fourths of distance to anal fin.

Color in arrack pale brownish-white. Each scale with pearly-leaden spot at its base leaving a vertical exposed streak, and more whitish on lower surface. A pale dusky-olive patch above eye. Side with five indistinct dusky-olive vertical transverse bands. First band below second flexible dorsal spine. Second extends down to large white patch which covers a good portion of costal region. In front of this a broad olive space merging in first transverse band. Second band begins below middle of spinous dorsal. Several scales at bases of third and fourth dorsal rays blackish, there third band begins. Fourth band begins below eighth, ninth and tenth dorsal rays, and last band on base of caudal. First two flexible dorsal spines and membranes dusky or blackish, dorsal fin otherwise pale yellowish-green, with a broad pale dusky margin, and marked with pale irregular oblique bars. Anal pale yellowish-green, with narrow oblique pale bars. Caudal pale, with several indistinct cross-lines. Pectoral and ventral pale brown.

Length $8\frac{3}{8}$ inches.

Type No. 27,730, A. N. S. P. Padang.

Also three cotypes. Closely related to *Hemipteronotus baldwini* Jordan and Evermann[1] from the Hawaiian Islands, but on comparison with one of the cotypes of that species *liogenys* is seen to have but few scales on the cheek and not extending down to the mouth. It also has a larger pectoral.

(Λεῖος, smooth; γένῦς, cheek.)

SCARIDÆ.

196. Scarus pinguirostratus sp. nov. Plate XXI, upper figure.

Head $2\frac{3}{4}$; depth $2\frac{1}{3}$; D. IX, 10; A. III, 9; P. II, 13; V. I, 5; scales 23 in lateral series to base of caudal; 2 scales between origin of spinous dorsal and lateral line; 8 scales between origin of spinous anal and lateral line; 25 scales in lateral line to base of caudal, last one on latter; width of head 2 in its length; depth of head, over anterior margin of eye, $1\frac{2}{5}$; snout $1\frac{9}{10}$; eye $9\frac{1}{4}$; mouth $5\frac{1}{6}$; maxillary $3\frac{1}{2}$; interorbital space 3; ninth dorsal spine $3\frac{1}{2}$; first dorsal ray from tip of anterior bifurcation 4; ninth $3\frac{2}{5}$; third anal spine $3\frac{1}{3}$; first anal ray from tip of anterior bifurcation $3\frac{1}{4}$; eighth $3\frac{4}{5}$; least depth of caudal peduncle $2\frac{2}{3}$; pectoral $1\frac{3}{7}$; ventral 2.

Body elongate, robust, well compressed, greatest depth near middle of pectoral, profiles evenly convex, and upper more so than lower. Caudal peduncle large, compressed, and its least depth about seven-eighths its length.

Head large, moderately compressed, cheeks a little flattened, and upper profile from above front of eye to occiput convex. Snout large, its surface convex, profile at first convex then slightly concave, and in front extending a little beyond upper mandible. Snout also soft to touch. Eye small, circular, high, and midway in length of head. Mouth inferior, and its corner extending about two-fifths in space opposite vertical from front of eye. Teeth developed as two sharp uneven-edged mandibles with a smooth convex surface, and more or less convex granulations along their edges. Two posterior canine teeth on each side of upper mandible. A thick fleshy buccal fold inside of each mandible. Tongue convex, thick, and not free. Lips tough and fleshy, though not covering much of mandibles. Maxillary extending about opposite posterior nostril. Nostrils small, lateral, inconspicuous, separated, though close together, and situated a little over an eye-diameter before, and a little inferior to, front margin of orbit. Interorbital space broad and convex. Opercular flap narrow.

Gill-opening extending forward about opposite anterior margin of eye. Gill-rakers 45, small, compressed, and ending in attenuated slender flexible points, longest about a third of orbit. Filaments long, numerous, longest four and seven-eighths in head. Gill-rakers on inner edge of first branchial arch well developed, similar to outer series, only a little longer. Pseudobranchiæ about three-fifths diameter of eye. Isthmus a little broad, membrane adnate, only forming a narrow frenum across.

[1] Bull. U. S. Fish. Comm., 1902 (1903), p. 192.

Scales large, cycloid, and those on middle of side with exposed widths a little less than half of exposed depths. Top of head, including interorbital space, opercle, subopercle, interopercle, and cheek scaly, other portions of head bare. Scales on opercle large. Three series of scales on cheek. Scales enlarged a little on chest. Fins scaleless, except base of caudal which is covered with enlarged scales. Ventral with an elongate scaly flap a little over two-fifths length of fin. Lateral line concurrent with back, sloping down below bases of last dorsal rays and extending along middle of side of caudal peduncle to base of caudal. Tubes of lateral line arborescent, many bifurcations on each scale.

Origin of spinous dorsal over that of pectoral, spines more or less equal, first a little shorter than others, and with flexible adipose ends, margin of fin entire. Soft dorsal inserted nearly opposite tip of pectoral or nearly midway between base of caudal and posterior margin of eye, rays of about equal length, and margin of fin with shallow notches or emarginations between rays. Anal inserted about opposite base of second dorsal ray, spines graduated to third which is longest, and each ending in a flexible and adipose tip, like those of dorsal. Soft anal with rays more or less similar, like those of dorsal. Caudal deeply lunate, upper and lower lobes prolonged into slender points. Pectoral broad, first divided ray longest, insertion of fin a little low in depth of body, and its posterior margin straight. Ventral inserted a little posterior to origin of pectoral, reaching two-thirds of distance to anal, and spine about half way. Anus close in front of origin of anal.

Color in arrack pale grayish-olive or dull olive-brown, lower surface paler or with more of a pale brownish hue. Each scale on back and sides tinged with dull greenish-yellow. Cheek dull greenish-yellow, and same color of cheek extending across chin. Upper lip largely greenish-yellow, and margin narrowly brownish. Several short radiating bars from eye. Fins mostly pale brownish, margins of dorsals and anals narrowly dull greenish-yellow. Caudal dull greenish-yellow. Pectoral with more or less dusky-olivaceous, margin broadly pale. Ventrals colored like belly. Peritoneum silvery, sprinkled with minute blackish specks or dots.

Length $25\frac{1}{2}$ inches.

Type No. 27,734, A. N. S. P. Padang.

(*Pinguis*, plump; *rostrum*, snout.)

197. Scarus calus sp. nov. Plate XXI, lower figure.

Head 3; depth $2\frac{2}{3}$; D. IX, 10; A. III, 9; P. II, 13; V. I, 5; 23 scales in a lateral series below lateral line to base of caudal; 2 scales between origin of spinous dorsal and lateral line; 8 scales obliquely back from origin of anal; 24 scales in lateral line, last one on base of caudal; width of head $1\frac{5}{6}$ in its length; depth of head over anterior margin of eye $1\frac{1}{2}$; snout $2\frac{1}{2}$; eye 8; mouth $5\frac{1}{3}$; maxillary 4; interorbital space $2\frac{2}{3}$; caudal $1\frac{1}{7}$, measured to tip of uppermost rays; least depth of caudal peduncle $2\frac{1}{2}$; pectoral $1\frac{3}{7}$; ventral 2.

Body rather deep, compressed, greatest depth near middle of pectoral, and back well arched in a convex profile. Caudal peduncle compressed, and its least depth equal to its length.

Head rather large, robust, compressed, and upper profile more convex than lower. Snout large, convex, both on surface and in profile, mandible not projecting in front. Eye small, circular, high, and its posterior margin nearly midway in head. Cheek flattened. Mouth inferior, upper mandible anterior, and corner reaching nearly opposite anterior nostril, maxillary concealed, though extending beyond. Mandibles convex, smooth, mosaic-like, and with uneven edges. A pair of posterior canines on each side of upper mandible. Lips broad, thin, not covering mandibles. A broad buccal flap inside of each mandible. Tongue rather large, convex, thick, and not free from floor of mouth. Nostrils small, near together, anterior with a small cutaneous rim, and both well before upper front rim of orbit. Interorbital space broad and convex. Opercular flap narrow.

Gill-opening extending forward about opposite posterior margin of eye. Gill-rakers about 50, fine, slender, short, weak, compressed, pointed, and longest about one-fifth of eye. Gill-filaments long, about one-fifth length of head. Pseudobranchiæ about five-sixths of eye. Isthmus broad, membrane forming but a narrow fold across.

Scales large, cycloid, and becoming enlarged on chest, those along middle of side with their exposed surfaces much deeper than broad. Head mostly scaly, those above extending well down on interorbital space. Opercle, subopercle and interopercle scaly, scales on former enlarged. Three rows of scales on cheek. Fins except base of caudal scaleless, and latter with three large terminal scales. An elongated scale at base of ventral a little less than half length of fin. Lateral line high at first, a little convex, not concurrent with dorsal profile, approaching near base of soft dorsal posteriorly where it descends abruptly till along middle of side of caudal peduncle, then extending out on base of caudal. Tubes with several bifurcations or only a little arborescent.

Origin of spinous dorsal about over that of pectoral, spines flexible, first a little shorter than last, otherwise more or less even in length. Margin of fin straight, and each spine with a thick fleshy or adipose-like end. Soft dorsal inserted well beyond tip of pectoral or nearer its origin than base of caudal, rays of more or less equal length, last shortest, and posterior end of fin rounded. Anal spines flexible, with fleshy or adipose-like ends, and graduated to third which is longest, origin of fin close behind that of soft dorsal. Soft anal similar to soft dorsal. Caudal truncate, with upper and lower rays produced into points, and posterior margin also truncate when fin is expanded. Pectoral broad, upper rays longest, and posterior margin straight. Also placed a little low in depth of body and not reaching opposite anus. Ventral inserted well behind pectoral, reaching about two-thirds distance to anal, first ray and spine with an adipose-like or fleshy extremity. Spine heavy and about five-sixths length of fin. Anus close in front of anal fin.

Color in arrack dull purplish-dusky above and on sides, lower surface whitish. Each scale on head above and sides, back and sides of trunk marked with short bars, lines and blotches of purplish-black, which form a beautiful intricate reticulating pattern of a more or less longitudinal nature. These lines and bars extend out over greater basal portions of dorsals. Dorsals and caudal dusky purplish-

brown, like general paler ground-color of back. Anal whitish. Pectoral with its upper half extending to tip of fin pale dusky-purplish, lower half of fin dilute yellowish-olivaceous. Ventral whitish. Iris tinged with orange. Peritoneum pale, shaded with dull purplish-black.

Length 16 inches.

Type No. 27,735, A. N. S. P. Padang.

One example. Closely related to *Scarus rubroviolaceus* Bleeker. According to Bleeker's figure[1] it differs in the presence of dark markings of trunk extending well out on bases of dorsal fins and profile of head above evenly convex.

(Καλὸς, beautiful.)

198. SCARUS CANTORI (Bleeker).

199. SCARUS QUOYI Valenciennes.

ILARCHIDÆ.

200. ILARCHES ORBIS (Bloch).

201. HARPOCHIRUS LONGIMANUS (Schneider). Plate XXIII, upper figure.

EPHIPPIDÆ.

202. EPHIPPUS ARGUS (Linnæus).

PLATACIDÆ.

203. PLATAX ORBICULARIS (Forskål).

204. PLATAX VESPERTILIO (Bloch).

CHÆTODONTIDÆ.

205. CHÆTODON VAGABUNDUS Linnæus.

206. CHÆTODON TRIFASCIATUS Park.

207. HENIOCHUS MACROLEPIDOTUS (Linnæus).

HARPURIDÆ.

HARPURUS Forster.

Harpurus Forster, Enchir. Hist. Nat., 1788,[2] p. 84 (no type indicated).[3]

Aspisurus Lacépède, Hist. Nat. Poiss., IV, 1802, p. 555 (*sohar* = *sohal*).

Forster's account does not include any species. It was supposed to be identical with *Acanthurus* Forskål (*monoceros*) = *Monoceros* Schneider. *Acanthurus* Forskål is rejected on the same basis as *Abu-defduf*, *Siganus*, etc.

208. HARPURUS GNOPHODES sp. nov. Plate XXII, upper figure.

Head $3\frac{7}{8}$; depth $2\frac{1}{3}$; D. IX, 25; A. III, 24; P. II, 15; V. I, 5; scales 135? in a median lateral series below lateral line to base of caudal; snout $1\frac{4}{5}$ in head; eye $4\frac{3}{4}$; maxillary $4\frac{2}{3}$; interorbital space $2\frac{5}{6}$; fifth dorsal spine $1\frac{2}{3}$; fifth dorsal ray $1\frac{2}{3}$; third anal spine $2\frac{1}{8}$; fifth anal ray $1\frac{4}{5}$; least depth of caudal peduncle $2\frac{3}{4}$; median caudal rays $1\frac{1}{3}$; ventral $1\frac{1}{3}$; width of head 2; pectoral $3\frac{2}{5}$ in trunk.

Body ovoid, well compressed, greatest depth about anus, profiles similar and evenly curved. Caudal peduncle compressed, and about as long as deep.

Head short, and profiles evenly convex. Snout long, convex, and upper jaw projecting but little in front. Eye round, high, anterior margin about midway in

[1] Atlas Ichth., I, 1862, pl. 13, fig. 3.

[2] The edition before me is the revised one published in London in 1797. It has the same paganation as the reference quoted above, which I have not consulted.

[3] *Sohal* is here restricted to this name to form an absolute synonym with *Aspisurus*.

head, one and three-quarters in interorbital space, and two and one-half in snout. Mouth a little low, little produced, and rounded in profile. End of maxillary well formed, slipping in obliquely vertical preorbital groove. Teeth uniserial, forming a compressed cutting edge, and each one also with a finely crenulated margin. Tongue thick, fleshy, and edges not free from mouth. Nostrils close together and also close to front of eye, anterior larger, with a cutaneous rim ending in a small flap behind. Interorbital space well elevated and convex. A deep groove running obliquely down from front of eye.

Gill-opening lateral, extending forward below posterior nostril. Gill-rakers 4 + 10, short compressed rudiments. Filaments equal orbit, and pseudobranchiæ about two-thirds of latter.

Scales minute ctenoid, a little larger on middle of side. A narrow basal scaly strip to each vertical fin. Bases of caudal and ventral scaly. Base and basal region of pectoral naked, though minute scales extend well out on membranes between rays. A keeled spine on caudal peduncle but little less than least depth of latter, and depressable in a deep groove. Lateral line rather indistinct at first, nearly concurrent with, though approaching nearer dorsal profile posteriorly, and continuing directly above groove of caudal peduncle till out on base of caudal. Tubes small and simple.

Spinous dorsal inserted a little behind origin of pectoral, graduated to posterior spines which are longest and more or less equal. Soft dorsal beginning nearly midway between tip of snout and base of caudal, rays high and similar, and posterior end of fin blunt. Spinous anal inserted before soft dorsal, spines graduated to third which is longest, and rayed fin like soft dorsal, except that it ends in a sharper point posteriorly. Caudal with median rays forming a straight posterior margin, and upper and lower ones produced into moderately long sharp points. Pectoral reaching well beyond origin of soft dorsal, and its lower margin straight. Ventral inserted a little behind origin of pectoral, pointed, reaching origin of soft anal, and spine reaching about five-eighths of distance. Anus close behind and nearer origin of ventral than anal.

Color in arrack chocolate-brown, with many narrow blue lines longitudinally. Fins all more or less blackish or dusky-brown, pectoral paler, with a tinge of dilute olivaceous. Peritoneum silvery, with brownish dots.

Length 14 inches.

Type No. 27,750, A. N. S. P. Padang.

One example. This species is distinguished by the median position of the mouth, which is level with the caudal spine, and the color in combination with the narrow bluish longitudinal lines.

(Γνόφώδης, obscure.)

209. CTENODON CTENODON (Valenciennes).

TEUTHIDIDÆ.

Subgenus TEUTHIS Linnæus.

210. TEUTHIS JAVUS Linnæus.

211. TEUTHIS VERMICULATUS (Valenciennes).
212. TEUTHIS VIRGATUS (Valenciennes).
213. TEUTHIS CORALLINUS (Valenciennes).

SIGANITES subgen. nov.

Type *Chætodon canaliculatus* Park.

Cheek naked or only with a small area including a few scattered scales. (From *Siganus*, an old name derived from the Arabic *Sidjan* or *Sigian.*)

214. TEUTHIS CANALICULATUS (Park).

TRIACANTHIDÆ.

215. TRIACANTHUS BREVIROSTRIS Schlegel.
216. TRIACANTHUS NIEUHOFII Bleeker.

BALISTIDÆ.

217. LEIURUS STELLARIS (Schneider).

ZENODON Swainson.

Xenodon Rüppell, Neu. Wirbel. Faun. Abyss. Fisch., 1835, p. 52 (*niger*).
Zenodon Rüppell, in Swainson, Lardner's Cabinet Cyclopædia, Nat. Hist., II, 1839, pp. 194, 325 (*niger*).
Erythrodon Rüppell, Verz. Mus. Senck. Nat. Ges., 1852, p. 34 (*niger*).

I adopt the above name as it is a little different from *Xenodon*, a genus of Ophidia, employed by Boie in 1827.

218. ZENODON CÆRULEOLORUM sp. nov. Plate XVIII, upper figure.

Head[1] $3\frac{1}{20}$; depth $1\frac{9}{10}$; D. III—II, 32; A. II, 27; P. I, 15; 35 series of scales between gill-opening and base of caudal, and 3 more on latter; about 24 scales in a transverse series between spinous dorsal and origin of anal; snout $1\frac{1}{3}$ in head, from its own tip; eye $5\frac{4}{5}$; interorbital space 3; first dorsal spine 2; third developed dorsal ray about $1\frac{1}{6}$; first developed anal ray about $1\frac{4}{7}$; pectoral $2\frac{1}{2}$; least depth of caudal peduncle $3\frac{3}{4}$.

Body deeply ovoid, well compressed, and greatest depth at pubic process. Caudal peduncle rather thick, rounded, and its length a little more than its least depth.

Head large, greatly compressed, upper profile obliquely horizontal and straight, and lower profile well convex. Snout long, and with a convex surface. Eye small, high, close to and a little less than equal to space between snout's upper margin. A deep groove extending obliquely down from front of eye. Mouth small, superior, mandible convex in front and produced beyond jaws. Teeth protruding, a single convex tooth on each side with a bevelled edge below. Mandibular teeth incisor-like and with their two pointed edges adjoining. Lips rather thin and tough. Nostrils minute, separated, and not far from front of eye over orbital groove. Interorbital space convex.

Gill-opening a little oblique. Filaments a little less than eye. About four small rounded ossifications above base of pectoral and close behind gill-opening.

Scales large, rather narrowly imbricated and more or less free on trunk, becoming smaller on anterior half of body and at bases of vertical fins, where they

[1] Measured from tip of mandible.

are all more or less inseparable. In space between mouth and gill-opening in vertical series, and on lower surface of head and abdomen forming oblique series parallel with lower profile line. Along bases of dorsal and anal elongate, narrow, and forming series somewhat similar to layers of bricks. Small scales on bases of caudal and pectoral.

Spinous dorsal depressable in a groove, and inserted a little in front of pectoral. First spine thick, finely roughened and more or less flattened in front, smooth and flattened and somewhat compressed laterally, end rounded. Soft dorsal inserted a little in front of anal, high in front where a pointed lobe is formed. Anal similar only lobe not pronounced. Pectoral small, broad, and rounded. Pubic process free, movable, and followed by about twelve short spines. Caudal moderate, median rays a little convex, and upper and lower forming long slender points. Anus surrounded by short spine-like processes, and placed just in front of anal fin.

Color in arrack black, with a dull bluish-slaty hue. Emargination of caudal narrowly whitish with a submarginal narrow line of bluish. Margins of dorsal and anal narrowly bluish. A broad black band from corner of mouth to lower edge of gill-opening, and bordered above and below broadly with bluish-gray. Margin of pectoral black. Teeth bright scarlet. Iris pale grayish-blue. Peritoneum white.

Length $15\frac{1}{4}$ inches.

Type No. 27,763, A. N. S. P. Padang.

Three examples. This species is related to *Zenodon niger* (Rüppell). Bleeker gives a figure which he identifies with *niger* though it does not agree as Rüppell neither indicates the blue and black lines from the snout to the gill-opening or mentions them in his description. My examples differ from Bleeker's in the black band from the corner of the mouth being well bordered with bluish on each side.

(*Cæruleus*, blue; *lorum*, bridle.)

219. Pachynathus capistratum (Shaw).
220. Balistapus undulatus (Park).

TETRAODONTIDÆ.

221. Lagocephalus lunaris (Schneider).
222. Lagocephalus albo-plumbeus (Richardson).
223. Tetraodon palembangensis Bleeker.
224. Tetraodon leiurus Bleeker.

OONIDUS Rafinesque.

Oonidus Rafinesque, Analyse de la Nature, 1815, p. 90 (*commersoni*).

Postfrontals and prefrontals deflected to describe a segment of a circle. Dorsal and anal small, each of about ten rays.

Lacépède's account, also Duméril's, are in the French vernacular. *Ovum* of Schneider is preoccupied.

225. Oonidus reticularis (Schneider).
226. Oonidus immaculatus (Schneider).

SCORPÆNIDÆ.

227. Sebastopsis polylepis (Bleeker).
228. Scorpænopsis oxycephala (Bleeker).
229. Pterois lunulata Schlegel.

NOTOTHENIIDÆ.

230. Parapercis atromaculata sp. nov. Plate XVIII, lower figure.

Head $3\frac{2}{5}$; depth at origin of spinous dorsal about 7; D. V, 21; A. I, 16; P. I, 16; V. I, 5; scales about 60 in lateral line, last 5 on base of caudal; scales 5 obliquely back from origin of spinous dorsal to lateral line, and 14[1] between latter and origin of anal; width of head $1\frac{4}{5}$ in its length; depth of head $2\frac{1}{5}$; mandible $2\frac{1}{10}$; snout $3\frac{1}{10}$ in head from its tip; eye 4; maxillary $2\frac{1}{2}$; interorbital space 13; third dorsal spine $4\frac{2}{3}$; third dorsal ray $2\frac{1}{2}$; third anal ray $2\frac{2}{3}$; least depth of caudal peduncle $3\frac{3}{4}$; caudal $1\frac{3}{5}$; pectoral $1\frac{2}{3}$; ventral $1\frac{2}{5}$.

Body elongate, subcylindrical at first, and becoming compressed above anal fin.

Head broad, and upper profile but slightly convex. Snout rather long and broadly depressed, with a convex surface, though pointed in profile. Eye high, directed upward, impinging on upper profile and a little elongate. Mouth large, superior, and mandible projecting. Maxillary reaching anterior rim of orbit. Lips thick. Teeth forming inner bands in jaws minute. An outer series of irregularly enlarged slightly curved canines also in each jaw. A small patch of vomerine teeth, none on palatines. Tongue elongate, rather slender, free in front, and its tip slightly rounded. Nostrils small, separated, anterior in a short cutaneous tube, and posterior a short round pore. Interorbital space narrow and flattened. Opercle with two short strong spines, lower anterior.

Gill-opening carried forward till about opposite posterior rim of eye? Rakers 6 + 12, short thick rudiments. Filaments about two-fifths of horizontal orbital diameter. Pseudobranchiæ a little smaller.

Scales mostly ctenoid, those in front of ventrals smooth. Scales on head small, especially those on cheek. Interorbital space, snout, lips, interopercle, and under surface of head naked. Small scales on basal portions of caudal and pectoral fins, and also extending out quite a distance on both upper and lower rays of former. Lateral line rather high at first, then descending posteriorly and running along middle of side of caudal peduncle and out on base of caudal. Tubes simple.

Dorsals continuous, spinous fin inserted well behind origin of pectoral, and third spine highest. Soft dorsal inserted a trifle nearer origin of pectoral than that of anal, fin of more or less even height, and margin more or less deeply incised above between each ray. Anal similar, caudal slightly rounded, corners forming angles. Pectoral reaching vent, and lower median rays longest. Ventral pointed, reaching anus, and first ray distinctly longer than innermost. Anus near anal.

Color in arrack dull brown, darker above, with a pale broad lateral band of ten oblong small blotches of pale brown extending from humeral region to base of caudal a little superiorly. Dark brown separating pale oblong areas continued

[1] My figure shows but nine on account of the flattened surface of anal region at this point.

above and below so as to form vertical bars. Side of head with seven brown dark-edged oblique bars extending backward below and behind eye. Snout more or less marbled with brown. Soft dorsal with three series of blackish-brown spots, one along base of fin, another median, and last submarginal. Anal with a single median series of round dusky spots extending longitudinally. Caudal with median rays whitish, marked with a number of round blackish spots, upper and lower edges of fin dusky. Pectoral and ventral dilute brown. Iris pale brownish. Peritoneum silvery-white.

Length 6 inches.

Type No. 27,780, A. N. S. P. Padang.

One example. This species is somewhat related to *Parapercis hexophtalma* (Cuvier)[1], but is easily distinguished by its coloration.

(*Ater*, dark; *macula*, spot.)

SILLAGINIDÆ.

231. Sillago sihama (Forskål).

MALACANTHIDÆ.

232. Malacanthus urichthys sp. nov. Plate XVI, lower figure.

Head $3\frac{1}{4}$; depth 6; D. 48; A. 38; P. I, 15; V. I, 5; scales 128 in lateral line, last six on base of caudal; about 11 scales[2] between origin of dorsal and lateral line, and about 25 between latter and origin of anal; width of head $2\frac{2}{5}$ in its length; depth of head, at posterior margin of eye, 2; snout $2\frac{1}{6}$; eye $6\frac{1}{3}$; mouth 4; maxillary $3\frac{1}{4}$; mandible $2\frac{3}{5}$; interorbital space $3\frac{4}{5}$; least depth of caudal peduncle $5\frac{1}{10}$; caudal $2\frac{1}{6}$; pectoral $1\frac{5}{6}$; ventral $3\frac{1}{6}$.

Body long, slender, compressed, and greatest depth at anterior pectoral region. Caudal peduncle compressed, and about as long as deep.

Head long, rather broad above, its sides well compressed, and pointed in front. Snout long, profile straight, its upper surface convex and upper jaw well produced in front. Eye circular, high, and a little posterior. Mouth terminally superior, lower jaw projecting a little in front, and maxillary reaching about opposite anterior nostril. Lips large, thick, fleshy, and plicate. Teeth fine, pointed, and in bands in jaws. Nostrils well separated, anterior a small pore about an eye-diameter directly in front of eye, and posterior similar, on lower edge of a small pit midway between. Interorbital space broad, slightly elevated above eye, and flattened. Opercle with short strong flattened spine.

Gill-opening extending forward a little in front of posterior edge of preopercle. Rakers 1 + 5 rudiments. Filaments about two-thirds of orbit. Pseudobranchiæ a trifle over half of orbit. Membrane forming a broad thick fold over wide isthmus.

Scales small and mostly finely ctenoid. Cheek, postocular region, opercle, especially above, occiput, back above and anteriorly, and chest, covered with elongate cycloid scales. Scales on abdomen and upper pectoral region rounded and

[1] Ehrenberg, in Cuvier, Hist. Nat. Poiss., III, 1829, p. 202.
[2] Not evident in my figure on account of the broad flattened back at this point.

cycloid. Scales along middle of side rather narrowly imbricated. Except base of caudal, which is covered with small scales, fins scaleless. A bare area at base of pectoral. Lateral line high at first, then sloping down and extending along middle of side of caudal peduncle and out on base of caudal. Tubes small and simple.

Dorsals continuous, spines small, much shorter than rays, and origin of fin about over pectoral. Soft dorsal beginning about opposite first third of pectoral, and fin of more or less uniform height, though becoming a little lower posteriorly. Anal inserted a little nearer tip of mandible than base of caudal, and anterior rays longest. Caudal unevenly emarginate, nearly straight when expanded. Pectoral with expanded rays, upper longest and forming a point that reaches origin of anal. Ventral inserted opposite origin of pectoral, and reaching about three-fifths of distance to anal.

Color in arrack olive-gray above, side and lower surface whitish. A broad blackish band from pectoral out over caudal to its margin, and upper and lower edges of latter dusky, otherwise whitish. Basal portion of dorsal somewhat dark gray-brown like back, and its margin paler. Anal whitish with a slightly dusky margin. Other fins whitish. Iris pale yellowish. Peritoneum white.

Length 14 inches.

Type No. 27,783, A. N. S. P. Padang.

One example. Griffith's figure of *Labrus vittatus*[1] is very crude, and may possibly be intended for this fish. The submarginal anterior dark line on the anal, if ever present, has faded completely. The black lateral band is not of the same pattern as it is shown in his figure, i. e., narrowing posteriorly.

(*Urichthys*, an old name applied to *Cheilinus*, a genus of Labroids which these fishes somewhat resemble.)

CALLIONYMIDÆ.

233. Callionymus sagitta Pallas.

PLATYCEPHALIDÆ.

234. Platycephalus indicus (Linnæus).

GRAMMOPLITES gen. nov.

Type *Cottus scaber* Linnæus.

Lateral line armed with spines.

(Γραμμὴ, line; ὁπλίτης, armed.)

235. Grammoplites scaber (Linnæus).

GOBIIDÆ.

ELEOTRIDINÆ.

236. Ophiocara porocephala (Valenciennes).
237. Eleotris fusca (Schneider).
238. Butis gymnopomus (Bleeker).

[1] Anim. King. Cuv., X, 1834, plate 45 (opposite p. 254, no description). No locality. (Not *Labrus vittatus* Walbaum.)

GOBIINÆ.

239. GOBIUS VENUSTULUS sp. nov. Plate XXI, lower figure.

Head $3\frac{1}{4}$; depth $5\frac{1}{2}$; D. VI—I, 10; A. I, 9; P. 17; V. 5 (5); scales 25 to base of caudal; scales 8 in a transverse series at origin of anal; depth of head about $1\frac{2}{3}$ in its length; width of head $1\frac{1}{2}$; snout $2\frac{4}{5}$; eye 4; width of mouth $2\frac{4}{5}$; maxillary $3\frac{1}{5}$; pectoral $1\frac{1}{6}$; ventral $1\frac{1}{3}$; second dorsal spine $1\frac{3}{4}$; first dorsal ray 2; last dorsal ray $1\frac{2}{5}$; first anal ray $2\frac{1}{4}$; last anal ray $1\frac{3}{5}$; caudal 1; least depth of caudal peduncle $2\frac{1}{4}$; interorbital space $2\frac{1}{2}$ in eye.

Body elongate, depressed in front, and sides compressed, more especially posteriorly. Greatest depth about belly. Caudal peduncle elongate, compressed.

Head rather large, depressed, lower surface more or less flattened, and upper surface convex or rounded. Upper profile steep and convex till above eye, after which it is more or less straight. Snout blunt, rather short, broad, and convexly rounded. Eye rather small, high, somewhat directed upward, and posterior margin a trifle behind middle of head. Jaws rather large and powerful, upper margin slightly protruding. Mouth rather small, broad, and maxillary reaching anterior margin of orbit. Lips rather thin, fleshy. Teeth large, sharp pointed, in broad bands and with an outer series somewhat enlarged. No vomerine or palatine teeth. Upper buccal flap rather broad. Tongue broad, thick, truncated, and not free in front. Nostrils small, anterior with a short elevated fleshy rim, and posterior directly in front of eye. Nostrils also separated, anterior in a short tube. Interorbital space narrow.

Gill-opening lateral, slightly oblique, and its length about two and two-fifths in head.

Scales large, thin, finely ctenoid. Head with small and crowded scales on top, otherwise naked.

Dorsal spines flexible, second longest, and all rather high. Fin inserted a little behind first third in length of trunk. Second dorsal inserted over origin of anal, rays more or less uniform in height but becoming more elongate posteriorly, last longest. Anal similar. Caudal elongate, median rays longest, and fin rounded when expanded. Pectoral long, broad, upper rays short and silky, and those just below middle of fin longest. Ventrals united, with a rather broad frenum in front, and when depressed reaching anus.

Color in arrack pale or dull olivaceous-brown above, lower surface whitish-brown without olivaceous tinge. Several series of small brown spots longitudinally on head and back. A brown streak below eye, and another behind lower margin of preopercle. A short black line on margin of preopercle. Opercle with a brown spot in middle. Several large deep brown spots in front of base of pectoral. Lower side of body with two longitudinal series of large deep brown blotches. Pectoral crossed by six or seven narrow pale blue cross-lines. Spinous dorsal with a whitish margin below which is a blackish shade. Spinous dorsal also with four or five blackish-brown inclined cross-lines. Soft dorsal with a number of slightly inclined rather long brownish lines extending over several rays. Anal brownish, with sim-

ilar but less distinct lines. Caudal with transverse series of dark brown blotches. Ventrals grayish-black.

Length $3\frac{1}{16}$ inches.

Type No. 27,799, A. N. S. P. Padang.

Two examples. This species is related to *Gobius sumatranus* Bleeker, but differs in coloration.

(*Venustulus*, pretty.)

ECHENEIDIDÆ.

240. Remora nieuhofii (Bleeker).

BLENNIIDÆ.

241. Scartichthys basiliscus sp. nov. Plate XIX, upper figure.

Head $4\frac{2}{5}$; depth $4\frac{3}{5}$; D. XIV, 8; A. II, 21; P. 14; V. 2; width of head $1\frac{1}{2}$ in its length; depth of head $1\frac{2}{5}$; eye $4\frac{1}{4}$; width of mouth $1\frac{5}{6}$; maxillary $2\frac{1}{6}$; fourth dorsal spine $1\frac{1}{2}$; fifteenth dorsal ray $1\frac{1}{6}$; eighteenth anal ray $1\frac{2}{3}$; least depth of caudal peduncle $2\frac{1}{4}$; caudal 1; pectoral $1\frac{1}{20}$; ventral $1\frac{5}{6}$.

Body rather deep, elongate, compressed, and greatest depth, though belly is emaciated, about origin of anal.

Head a little oblong, widest below, upper surface somewhat constricted, of more or less equal depth, and anterior profile steep. Snout broader than long and with a convex surface, its profile steep. Eye high, deeper than long, and well anterior. Mouth broad, jaws large, and maxillary reaching a little behind posterior margin of eye. Teeth minute, forming a comb-like series in each jaw but without a posterior canine. No teeth on vomer. Tongue large, thick, and not free. Nostrils circular, separate, with cutaneous rims, and anterior followed by a fleshy arborescent tentacle. Interorbital space narrow and concave. Head surmounted by a rather high median cutaneous flap or crest. A supraocular tentacle equal to vertical diameter of eye. A tentacle opposite end of crest on top of head on each side of occiput.

Gill-membrane forming a broad fold over a broad isthmus and falling well behind eye. Rakers small, short, and in moderate number. Filaments and pseudobranchiæ small.

Spinous dorsal high, beginning before origin of pectoral, spines flexible at least terminally, longest and more or less equal anteriorly and medianly, and rounded margin of fin entire. Soft dorsal separated by a deep notch, joined posteriorly with caudal by a membrane, rounded margin of fin hardly notched, and posterior rays a little longest. Anal beginning a little before origin of soft dorsal. Preceding rays two small flexible spine-like rudiments. Rays more or less equal, and margin of fin deeply notched. Caudal elongate and rounded. Pectoral broad, rounded, lower rays longest, and fin notched. Ventral inserted close behind anterior edge of gill-opening, and composed of two thick rays, inner a little longer.

Color in arrack deep drab with a tinge of heliotrope or purplish. Side with about eight pairs of broad transverse bands of a deeper shade than body color, alternating broader pale bands also with darker but narrow transverse band. On bases

of dorsals they extend for a short distance, but below do not reach lower surface of abdomen or base of anal. Head more or less variegated with dusky, and a dark transversely oblique band bordered with paler on each side extending down behind eye. Two dark bars from eye to maxillary. Fins dusky-blackish, bases paler. Spinous dorsal with about four longitudinal grayish lines, upper darker and more or less diffuse with dark color of that part of fin. Grayish lines extending longitudinally though inclined posteriorly. Anal with four grayish lines, outer two closer, and somewhat broken and interrupted in places. Indistinct traces of grayish cross-bands on caudal. Margins of vertical fins show little or no evidence of reticulations formed by grayish lines. Pectoral and ventral with more or less grayish and brownish. Iris brownish. Peritoneum whitish.

Length $4\frac{3}{4}$ inches.

Type No. 27,802, A. N. S. P. Padang.

One example. This species appears to be related to *Salarias oortii*, but differs in the coloration and fin radii.

(Βασιλίσκος, *Basiliscus.*)

242. SCARTICHTHYS STIGMATOPTERUS sp. nov. Plate XIX, lower figure.

Head $4\frac{1}{2}$; depth $6\frac{1}{5}$; D. XIII, 22; A. II, 23; P. 13; V. 2; width of head $1\frac{3}{4}$ in its length; depth of head $1\frac{1}{3}$; eye 4; width of mouth $2\frac{1}{3}$; maxillary $2\frac{2}{5}$; fourth dorsal spine 2; fifteenth dorsal ray $1\frac{1}{3}$; eighteenth anal ray $1\frac{1}{2}$; least depth of caudal peduncle $2\frac{2}{3}$; caudal $1\frac{1}{20}$; pectoral $1\frac{1}{10}$; ventral $1\frac{7}{8}$.

Body elongate, well compressed, and greatest depth probably through belly.

Head similar to preceding, except not so much constricted above, with broad fringed cutaneous flap over eye, and no occipital tentacle.

Gill-opening and fins similar to preceding.

Color in arrack deep drab with a tinge of pale heliotrope or purplish. Side with about seven pairs of broad transverse bands, darker than body color, space between each pair somewhat narrower than either dark band and also with a narrow dark median transverse line or band. These bands also extend diffusely out on bases of dorsals, but not on lower surface of abdomen or to base of anal. Head more or less plain-colored, a little darker above, and two dark bars from eye to maxillary. Fins pale, marginal portion broadly dusky or blackish. Margins of dorsals and most of upper half of caudal finely reticulated with narrow grayish hues. On spinous dorsal these give place more or less to longitudinal broad pale bands, and on soft dorsal to oblique grayish lines, inclined a little, and extending to upper reticulations of fin. Oblique lines of dusky on anal between rays distally. Pectoral and ventral pale.

Length $3\frac{1}{2}$ inches.

Type No. 27,803, A. N. S. P. Padang.

Two examples. They do not agree with any of the descriptions as they have 13 dorsal spines, though probably closer to Bleeker's second account[1] of *Salarias*

[1] Act. Soc. Sci. Ind. Neerl. (Zes. Bijd. Visch. Sumatra), III, 1857, p. 39.

oortii or that by Dr. Günther.[1] Bleeker's first account[2] is incomplete and may refer to a different species.

(Στίγμα, spot; πτέρωμα, fin.)

243. Entomacrodus leopardus sp. nov. Plate XXI, upper figure.

Head $4\frac{2}{5}$; depth $6\frac{2}{5}$; D. XII, 19; A. I, 20; P. 14; V. 2; width of head $1\frac{3}{5}$ in its length; depth of head $1\frac{2}{5}$; eye $3\frac{1}{2}$; width of mouth $2\frac{2}{5}$; pectoral 1; ventral $1\frac{4}{5}$; caudal $1\frac{1}{5}$; interorbital space $2\frac{1}{2}$ in eye.

Body long, and well compressed.

Head oblong, contricted above, broad below, and of more or less equal depth. Upper profile nearly horizontal and without a fleshy flap or crest. Snout broad, steep, inclining a trifle inward so that above, at interorbital space, it is a little inclined beyond mouth. Eye far forward, high, circular, and nearly impinging on upper profile. Space between lower margin of eye and corner of mouth less than eye-diameter. Mouth low, inferior, end of maxillary reaching a little beyond posterior margin of eye. Teeth fine, in a narrow comb-like series in each jaw. No vomerine teeth. Mandible with a small posterior canine on each side. Lips rather thin, smooth, and entire. Tongue adnate to floor of mouth. Nostrils well separated and anterior with two small fleshy flaps. A small thin tentacle above eye. Interorbital space narrow, slightly concave.

Gill-opening large, membrane broad, and free across broad isthmus. Rakers short, weak, not numerous, much shorter than filaments. Pseudobranchiæ well developed.

Spinous dorsal a little lower than soft dorsal, and its base also a little shorter. Spines of more or less uniform height, flexible, and well separated from soft fin by a deep notch. Soft dorsal joined to caudal posteriorly by a membrane. Anal preceded by a small flexible spine, hardly distinguishable from rays, and margin of fin distinctly incised between rays. Last anal ray not connected with caudal peduncle by a membrane. Caudal elongate, margin slightly convex. Pectoral broad, rays just below middle longest, and lower ones enlarged. Ventral inserted nearly midway between posterior rim of eye and gill-opening.

Color in arrack uniform pale brown. Vertical fins and posterior side of body marked with numerous small round dark or blackish-brown spots. Tips of anal rays whitish. Along anterior side of body several indistinct **H**-shaped pale markings, giving place to dark dots posteriorly, though along middle of that region a median series of short horizontal lines. A pale brown spot on opercle. Pectoral brownish, darker on outer portion. Ventral pale brown.

Length $2\frac{3}{16}$ inches.

Type No. 27,805, A. N. S. P. Padang.

Two examples.

(*Leopardus*, leopard; from the dark spots.)

[1] Cat. Fish. Brit. Mus., III, 1861, p. 257.
[2] Nat. Tijds. Ned. Ind., I, 1850, p. 257.

244. ENTOMACRODUS CALURUS sp. nov. Plate XX, ♂ above, ♀ below.

Head 5; depth $6\frac{3}{4}$; D. XII, 20; A. II, 20; P. 14; V. 2; width of head $1\frac{4}{5}$ in its length; depth of head $1\frac{1}{2}$; eye $3\frac{1}{2}$; width of mouth $2\frac{1}{4}$; pectoral $1\frac{1}{3}$; ventral 2; caudal 1; interorbital space 3 in eye.

Body elongate, compressed, oblong, greatest depth about middle of belly.

Head elongate, compressed, oblong, and of more or less equal depth. Upper profile nearly horizontal, and surmounted by a thin rather high fleshy flap or crest. Snout nearly vertical, broad, convex, and slightly produced beyond mouth. Eye far forward, nearly impinging on upper anterior profile. Space between its lower margin and corner of mouth a trifle less than vertical diameter. Mouth low, inferior, broad, its corner reaching below posterior rim of orbit. Teeth in a narrow comb-like band in each jaw. Mandible with a strong canine on each ramus. Lips rather thin, but fleshy. Nostrils well separated, and lower with three or four short fleshy filaments. A thin fleshy tentacle above eye equal to three-fourths its diameter. Interorbital space narrow, slightly concave.

Gill-opening rather large, membrane broad, and free across rather broad isthmus. Rakers short, weak, not numerous, and much shorter than filaments. Pseudobranchiæ well developed.

Spinous dorsal shorter than soft dorsal, also lower, spines of more or less uniform height, flexible, and well separated from soft fin by a deep notch. Soft dorsal joined to caudal posteriorly by a membrane. Anal preceded by two small flexible spines hardly distinguishable from rays, and margin of fin distinctly incised between rays. Last anal ray free from caudal peduncle posteriorly. Caudal elongate, rounded. Pectoral broad, rays just below middle longest. Ventral inserted below posterior portion of crest on head.

Color in arrack uniform pale brown. Side with about eight pairs of indistinct dusky vertical cross-bars, and on each several short pale blue dark-edged horizontal bars formed in lateral series. Spinous dorsal gray, blackish on outer portion and edge. Soft dorsal gray with about six dusky inclined lines extending across. Anal gray, darker on outer portion and with a blackish edge adjoining a submarginal narrow blue line or band. Caudal with lower portion of fin dusky, greater part of fin gray above and crossed with about five narrow brown cross-bars, also finely marbled. Pectoral and ventral pale brownish.

Length 3 inches.

Type ♂ No. 27,807, A. N. S. P. Padang.

Also five others, ♀, cotypes. The females have no crests and lack the submarginal anal line.

(Καλὸς, beautiful; οὐρὰ, tail.)

PLEURONECTIDÆ.

245. PSETTODES ERUMEI (Schneider).
246. PARALICHTHYS POLYSPILUS (Bleeker).
247. PARALICHTHYS TRIOCELLATUS (Schneider).

SOLEIDÆ.

248. CYNOGLOSSUS OS sp. nov. Plate XXII, upper figure.

Head $3\frac{1}{2}$; depth $3\frac{2}{5}$; D. about 102; A. about 4—76; caudal 8; space between tip of snout and upper eye $2\frac{1}{4}$ in head; mouth cleft $5\frac{1}{5}$; upper eye $5\frac{1}{2}$ in space to tip of snout; interorbital space $5\frac{1}{2}$; scales in lateral line, from above branchial aperture to base of caudal, about 86; about 40 scales in a transverse series at deepest part of body; 12 scales between lateral line at same point.

Body elongate, greatly compressed, sinistral, and greatest depth would fall about first two-fifths of length of fish. Tail long, tapering narrowly posteriorly.

Head large, profile evenly rounded above and below. Snout rather long, compressed and rounded. Eyes small, close together, and upper nearly altogether in advance of lower. Posterior margin of lower eye a little nearer gill-opening than anterior margin of upper eye is nearer to tip of snout. Mouth large, its cleft horizontal. Teeth rather fine, sharp pointed, and in bands only on dextral side of jaws. Sinistral side of jaws with a labial fringe of small fleshy flaps. Tongue rather thick, rounded and little free. Upper nostrils damaged. Lower nostril a small fleshy tube below and anterior to lower eye, or hardly below middle of upper. Interorbital space rather narrow and flattened.

Gill-opening small, membrane broad and forming a broad fold over narrow compressed isthmus. Rakers none. Gills small, filaments small.

Scales small, ctenoid, and spread over entire body, except on fins. Lateral system of mucous pores double along trunk, median series begins near tip of snout and runs direct to caudal. Upper series confluent with this at its origin, and again about midway between upper eye and gill-opening, extending along upper portion of body close to and just below dorsal fin, then out on fifth ray from caudal. A system of mucous pores runs down from intersecting series, between eyes and gill-opening, and across side of head. Also another series of pores from front of eye obliquely down to lower margin of snout. No pores on dextral side of fish.

Confluent with caudal are long dorsal and anal, former divided at first by anus so that first four rays are separated from rest of fin. Caudal rather long and pointed.

Color in arrack, sinistral side pale olive, finely mottled with darker. Dextral side a livid whitish or brownish-white. Fins pale brown.

Length 5 inches.

Type No. 27,816, A. N. S. P. Padang.

One example. It is close to *C. sumatranus* Bleeker, and agrees with the same author's figure except that there is no oblique series of tubes before the eye. Seventy scales are given for the lateral series while my example shows about eighty-six scales in the lateral line.

(*Os*, mouth.)

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[1] Vischsoorten, nieuw voor de kennis der fauna van Singapoera, verzameld door Fr. Graaf de Castelnau. L. c., XXII (II), pp. 101-102. (May 1860.)
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Besides the above, the invaluable eight volumes of Dr. Günther's "Catalogue of the fishes in the British Museum" and the second edition started by Dr. Boulenger, together with the "Atlas Ichthyologique des Indes orientales Neerlandaises" by Dr. P. v. Bleeker, and the "Fishes of India," by Dr. Day, will furnish a clue to most all of the literature. The last work will also be found useful in referring to papers on the islands north of Sumatra (pp. vii-viii, preface).

EXPLANATION OF PLATES VII–XXVIII.

All of the figures were drawn from the types or examples in the collection of the Academy of Natural Sciences of Philadelphia. The specimens are from Padang unless otherwise stated. The line accompanying each figure represents an inch.

PLATE VII.—Hippocampus tæniops Fowler. Type No. 27,409.
Parapegasus natans (Linnæus). No. 27,468.
Trichiurus haumela (Forskål). No. 27,492.

PLATE VIII.—Mastacembelus unicolor Valenciennes. No. 27,456. *Batu Sangkar.*
Germo germon (Lacépède). No. 25,129.

PLATE IX.—Tylosurus crocodilus Lesueur. No. 27,462.
Sphyræna toxeuma Fowler. Type No. 27,470.
Ophicephalus spiritalis Fowler. Type No. 27,664.

PLATE X.—Holocenthrus aureoruber Fowler. Type No. 27,472.
Alepes scitula Fowler. Type No. 27,503.

PLATE XI.—Liza cæruleomaculata (Lacépède). No. 25,128.
Seriola cretata Fowler. Type No. 27,499.

PLATE XII.—Scomber kanagurta Rüppell. No. 27,474.
Alepes glabra Fowler. Type No. 27,502.

PLATE XIII.—Caranx megalaspis (Bleeker). No. 27,504.
Caranx mate Valenciennes. No. 27,508.

PLATE XIV.—Caranx sem Valenciennes. No. 27,514.
Citula atropos (Schneider). No. 27,520. Young.
Leiognathus spilotus Fowler. Type No. 27,529

PLATE XV.—Carangoides gibber Fowler. Type No. 27,517.
Gazza tapeinosoma Bleeker. No. 27,534.
Leiognathus vermiculatus Fowler. Type No. 27,525.
Leiognathus virgatus Fowler. Type No. 27,526.

PLATE XVI.—Caranx semisomnus Fowler. Type No. 27,512.
Polydactylus pfeifferi (Bleeker). No. 27,635.

PLATE XVII.—Plectropoma pessuliferum Fowler. Type No. 27,546.
Bodianus indelebilis Fowler. Type No. 27,553.

PLATE XVIII.—Epinephelus heniochus Fowler. Type No 27,557.
Lutianus furvicaudatus Fowler. Type No. 27,596.

PLATE XIX.—Cæsio erythrochilurus Fowler. Type No. 27,621.
Pomacentrus leucosphyrus Fowler. Type No. 27,673.
Premnas epigrammata Fowler. Type No. 27,665.

PLATE XX.—Halichœres annulatus Fowler. Type No. 27,713
Thalassoma melanochir Fowler. Type No. 27,724.
Hemipteronotus liogenys Fowler. Type No. 27,730.

PLATE XXI.—Scarus pinguirostratus Fowler. Type No. 27,734.
Scarus calus Fowler. Type No. 27,735.

PLATE XXII.—Harpurus gnophodes Fowler. Type No. 27,750.
Malacanthus urichthys Fowler. Type No. 27,783.

PLATE XXIII.—Harpochirus longimanus (Schneider). No. 27,741.
Thalassoma lunare (Linnæus). No. 27,723.

PLATE XXIV.—Zenodon cæruleolorum Fowler. Type No. 27,763.
Parapercis atromaculata Fowler. Type No. 27,780.

PLATE XXV.—Scartichthys basiliscus Fowler. Type No. 27,802.
Scartichthys stigmatopterus Fowler. Type No. 27,803.

PLATE XXVI.—Entomacrodus calurus Fowler. Type No. 27,807 ♂. Cotype No. 27,808 ♀.

PLATE XXVII.—Entomacrodus leopardus Fowler. Type No. 27,805.
Gobius venustulus Fowler. Type No. 27,799.

PLATE XXVIII.—Cynoglossus os Fowler. Type No. 27,816.
Chlarias olivaceus Fowler. Type No. 27,280.

Plate I.

First Maturation Division of Crepidula plana.

Fig. 1.—Ovarian egg showing germinal vesicle and spot, the latter composed of two parts.

Fig. 2.—Unfertilized egg from the uterus; optical section showing what appear to be two centrosomes lying next the nucleus. Obj. 3 mm., Occ. 4 (Zeiss Apochromat).

Figs. 3 and 4.—Fertilized eggs from the uterus showing indentation of the nuclear membrane, linin network and growth of chromosomes. Obj. $\frac{1}{16}$ (Leitz), Occ. 4.

Figs. 5 7.—Fertilized eggs just laid; formation of spindle and elimination of chromatin and nucleolus.

Fig. 8.—Prophase of first maturation; chromosomes of various shapes, centrosomes irregular in outline.

Fig. 8a.—Tangential section through centrosome and sphere of a stage similar to Fig. 8.

Figs. 9 and 10.—Early metaphase showing two characteristic positions of spindle. Obj. 3 mm, Occ. 4.

Fig. 11.—Same as preceding, showing cross-shaped chromosomes and irregular centrosomes with light center.

Fig. 12.—A characteristic metaphase; chromosomes accurately drawn both as to form and position; the chromosome Ch'. is displaced out of spindle, probably by the knife. Centrosomes show clear center.

Fig. 12a.—Cross section through the equator of a spindle of the stage of preceeding. Processes of spindle substance radiate into the cytoplasm. Many chromosomes are surrounded by a linin sheath.

Fig. 13.—Early metakinesis; the daughter chromosomes are connected by linin threads which in some cases are moniliform. The centrosomes are hollow and the spheres more regular than in preceding stages.

Fig. 14.—Anaphase; interfilar substance of spindle between chromosomes and spheres; chromosomes with faintly staining centers; centrosomes contain a hollow central corpuscle; peripherel centrosome and sphere flattened against the egg membrane.

Fig. 15.—The chromosomes lie at the borders of the spheres; centrosomes and central corpuscles elliptical; protrusion of outer pole of spindle.

Fig. 16a.—Connective fibres granular; central corpuscle transformed into amphiaster (netrum) of second maturation division; outer pole of spindle not protruding.

Fig. 16.—Slightly later stage than preceeding; chromosomes pass into spheres; centrosomes and inclosed amphiasters (netra) at both poles; protrusion of first polar body.

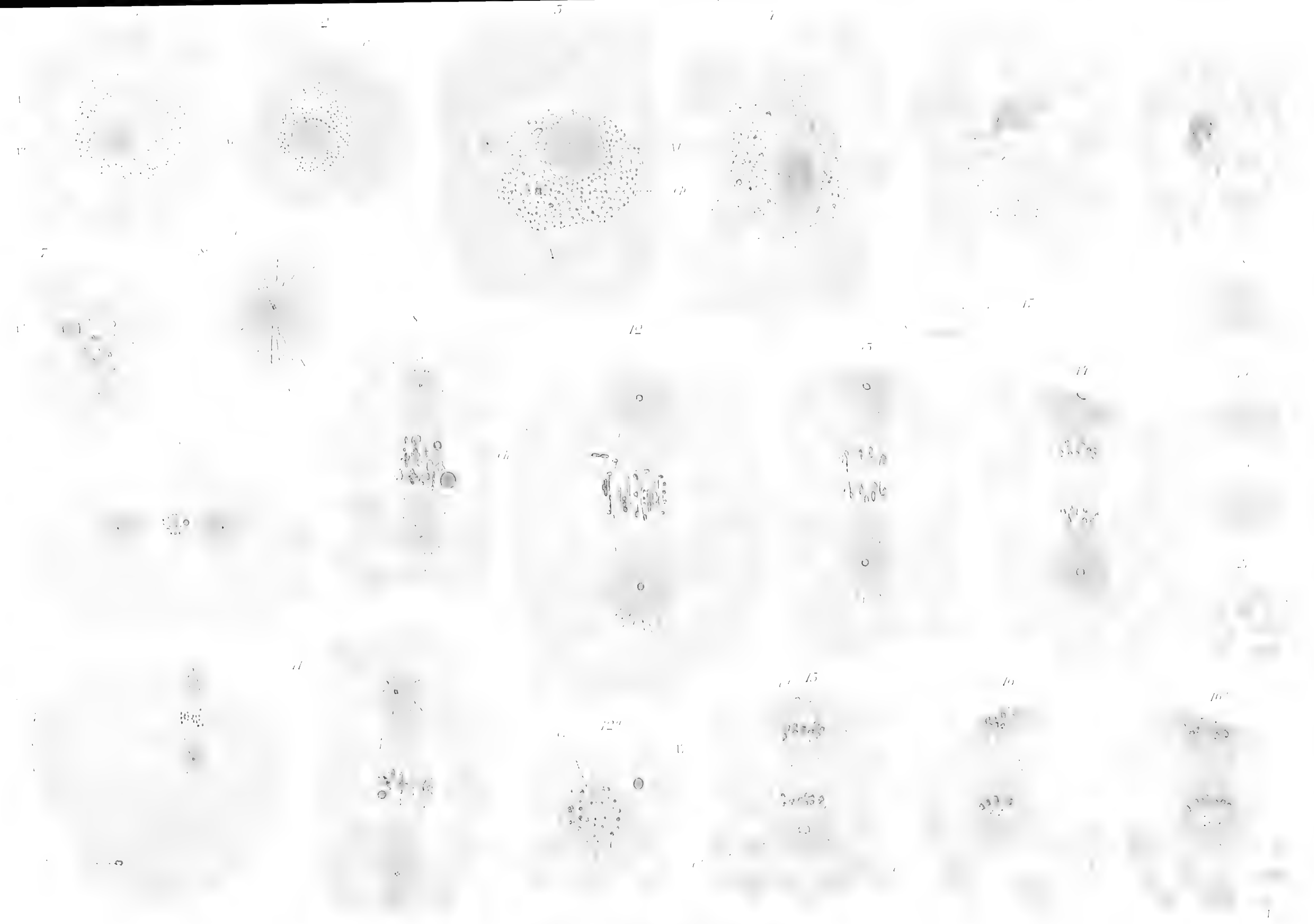
Fig. 17.—Mature spermatozoon of *C. plana*.

Fig. 18.—Sperm head immediately after entering the egg from a preparation of the same stage as Fig. 3.

Fig. 19.—Rotation of sperm head; appearance of middle piece granules; egg in stage of Fig. 4.

Fig. 20.—Shortening of sperm head; egg in stage of Figs. 5–7.

Fig. 21.—Formation of sperm nucleus; egg in stage of Figs. 10–14.



CONKLIN. Karyokinesis and Cytokinesis.

Plate II.

Second Maturation and Fecundation of C. plana.

Fig. 22.—Separation of first polar body ; amphiaster (netrum) of second maturation still within the old centrosome, amphiaster also in the first polar body.

Fig. 23.—Similar to preceding ; formation of ring-shaped mid-body (*Zwischenkörper*).

Figs. 24 and 25.—Growth of amphiaster within egg centrosome.

Fig. 26.—Outlines of the old centrosome have disappeared ; amphiaster lies free in the cytoplasm surrounded by chromosomes ; the new astral rays are independent of the old, which are centered on the amphiaster as a whole.

Figs. 27 and 28.—Two different positions of the second maturation spindle.

Fig. 28a.—Early stage in division of the first polar body. Obj. $\frac{1}{16}$ (Leitz), Occ. 4.

Fig. 29.—Spindle much stouter than in previous stages ; outer pole of spindle lies immediately under the mid-body (*Zwischenkörper*).

Fig. 30.—Metaphase of second maturation; cross-shaped chromosomes in maturation spindle and in first polar body.

Fig. 31.—Tetrad-like chromosomes in the second maturation spindle ; separation of the halves of these chromosomes into dumb-bell shaped bodies.

Fig. 32.—Anaphase of second maturation ; chromosomes dumb-bell and rod shaped ; centrosomes hollow ; first polar body divided.

Fig. 33.—Stage a little later than preceding ; chromosomes rounded, connective fibres granular ; central area of centrosome granular.

Fig. 34.—Separation of second polar body and division of first ; granular centrosome and sphere left in egg ; chromosomes vesicular ; mid-body well marked.

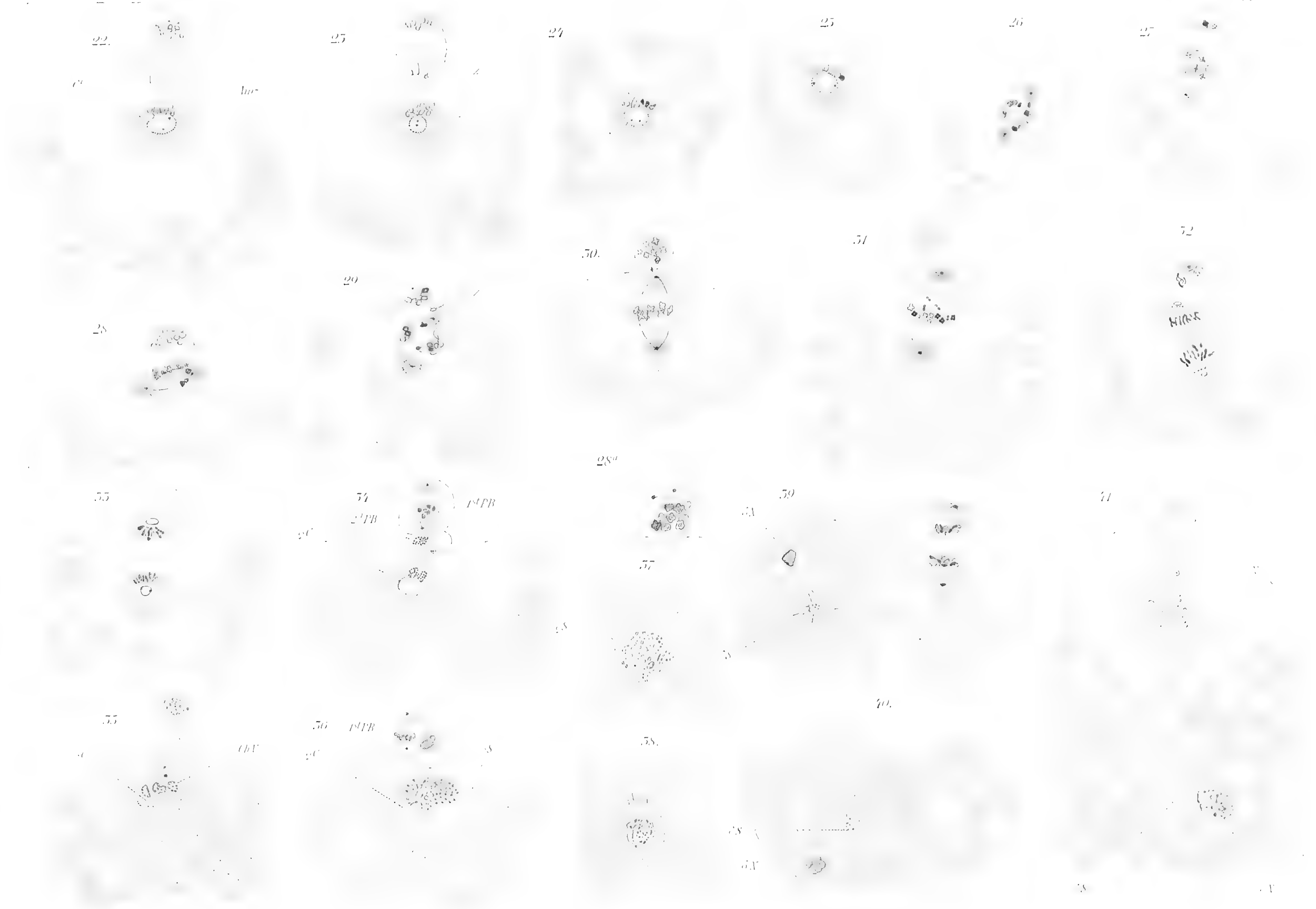
Fig. 35.—Similar to preceding ; chromosomal vesicles are surrounded by the sphere.

Fig. 36.—Reticular egg nucleus present and surrounded by the sphere ; centrosome a faint granular mass.

Figs. 37 and 38.—Polar views of egg nucleus surrounded by sphere.

Figs. 39 and 40.—Anaphase of second maturation ; first appearance of sperm aster around granules of middle piece.

Fig. 41.—Approach of sperm nucleus and sphere to those of egg.



CONKLIN Karyokinesis and Cytokinesis

Plate III.

Fecundation and First Cleavage of C. plana

Figs. 42 and 43.—Approach of sperm nucleus and sphere to those of egg ; one accessory aster in each egg ; one large accessory aster present. Obj. 3 mm., Occ. 4.

Fig. 44.—Union of egg sphere and sperm sphere ; contact of germ nuclei. Obj. 3 mm., Occ. 4.

Fig. 45.—Germ nuclei in contact ; spheres still distinct ; yolk granules between the two spheres and nuclei.

Fig. 46.—Egg and sperm spheres fused and yolk granules inclosed. Obj. 3 mm., Occ. 4.

Fig. 47.—The fused spheres surround the germ nuclei ; cleavage centrosomes appear at border of spheres. Obj. 3 mm., Occ. 4.

Fig. 48.—Sphere substance no longer visible ; one centrosome and sphere in connection with each germ nucleus ; same stage as Fig. 53. Obj. 3 mm., Occ. 4.

Fig. 49.—Germ nuclei surrounded by the fused spheres.

Figs. 50 and 51.—Similar to preceding ; cleavage centrosomes appear at the border of the fused spheres ; chromatin granules vesicular.

Fig. 52.—Cleavage centrosomes at the poles of the germ nuclei ; no central spindle ; chromatin granules vesicular. Obj. $\frac{1}{16}$ (Leitz), Occ. 4.

Fig. 53.—One centrosome and half spindle in connection with each germ nucleus ; nuclear membrane indented opposite centrosomes ; chromosomes forming out of granules, other granules dissolving in nuclear sap.

Fig. 54.—First appearance of central spindle between the two cleavage centrosomes ; chromosomes aggregating in the spindle ; other granules dissolving ; spheres increasing in size and substance radiating from them through the cytoplasm.

Fig. 55.—Prophase of first cleavage ; oxychromatin granules arranged along the spindle fibres. Obj. $\frac{1}{16}$ (Leitz), Occ. 4.

Fig. 56.—Metaphase of first cleavage ; "heterotypic" division of the chromosomes.

Fig. 57.—Similar to preceding ; centrosomes slightly hollow.

Fig. 58.—Anaphase of first cleavage ; centrosomes hollow ; spheres alveolar.

Fig. 59.—Late anaphase ; chromosomal vesicles closely appressed to sphere ; centrosomes and spheres filled with a delicate reticulum.

Fig. 60.—Telophase of first cleavage ; beginning of the bending of the spindle axis ; nucleus in the left cell partly divided into two portions of which the upper half is from the egg nucleus and the lower from the sperm.

Fig. 61.—Resting stage at close of first cleavage ; spindle axis bent on itself through nearly 180°; nuclei almost in contact with each other, centrosomes and spheres near surface and mid-body carried down to the middle of the egg. The mid-body is a hollow sphere, like a centrosome, surrounded by a dark area, like a sphere.

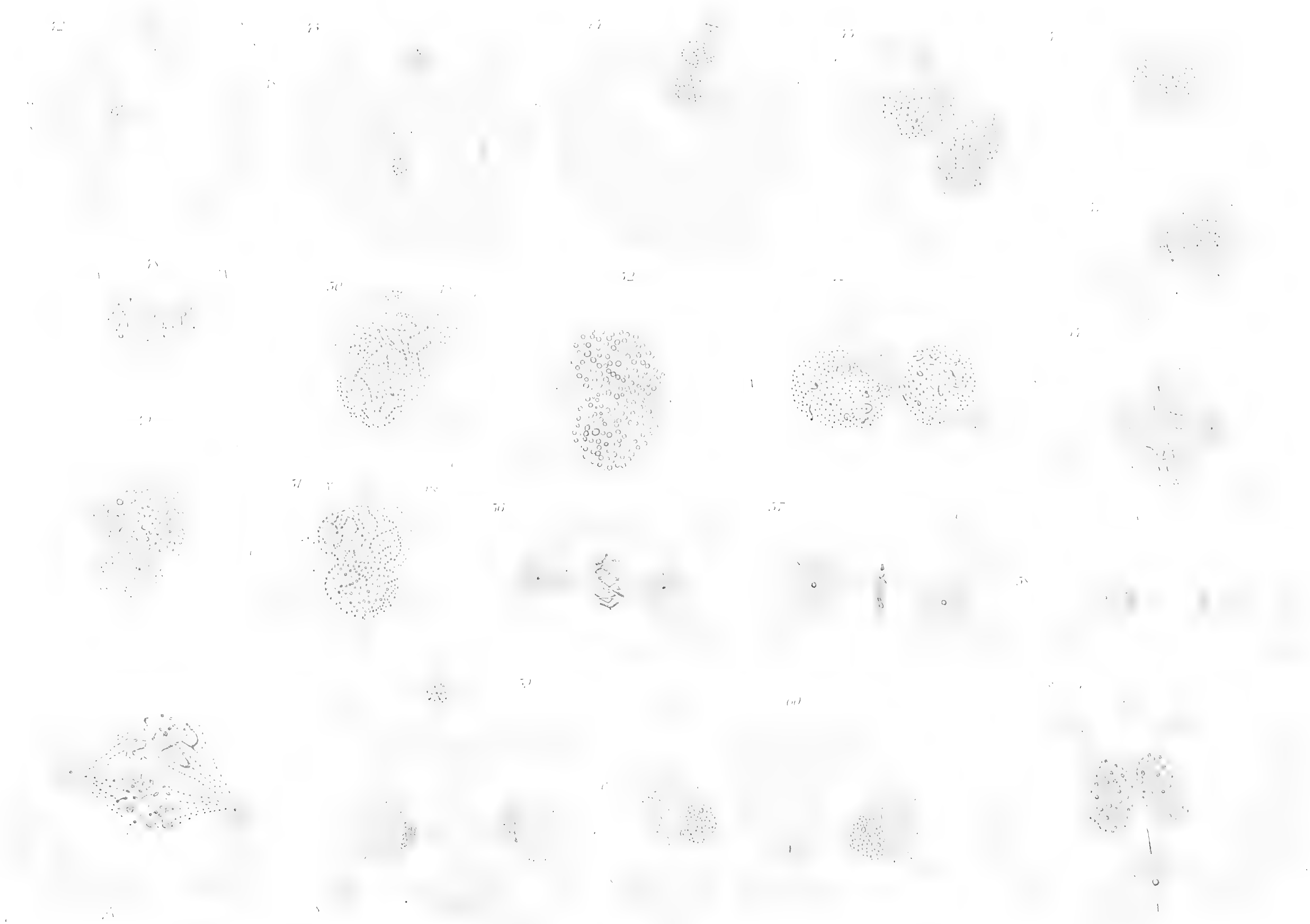


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Plate IV.

Second, Third and Fourth Cleavages of C. plana.

Fig. 62.—Similar to preceding; nucleus in early prophase.

Fig. 63.—Section at right angles to preceding; amphiaster for second cleavage present.

Fig. 64.—Prophase of second cleavage. (Omitted from plate for lack of space and put in text as fig. XVIII.)

Fig. 65.—Metaphase of second cleavage.

Fig. 66.—Anaphase of second cleavage; chromosomes at the borders of the spheres; latter alveolar.

Fig. 67.—Anaphase of second cleavage; chromosomal vesicles apparently absorbing substance from spheres.

Fig. 68.—Telophase of second cleavage (horizontal section); centrosomes faintly granular.

Fig. 69.—Rest stage at close of second cleavage; centrosomes densely chromatic.

Fig. 70.—Amphiasters for third cleavage moving out of spheres and old centrosomes; nuclei show polar differentiation of the chromatin.

Fig. 71.—Prophase of third cleavage; nuclei indented; sphere remnants at apical pole.

Fig. 72.—Metaphase of third cleavage.

Fig. 73.—Telophase of third cleavage.

Fig. 74.—Resting stage after third cleavage. Centrosomes are reticular spindles.

Fig. 75.—Same stage as preceding; section through one macromore showing the centrosome, which becomes the amphiaster of the fourth cleavage, as a reticular spindle.

Fig. 76.—Subdivision of the first quartette; spindle in metaphase in one cell; amphiaster just escaped from the sphere in the other; nucleus and spheres of the second quartette cells shown.

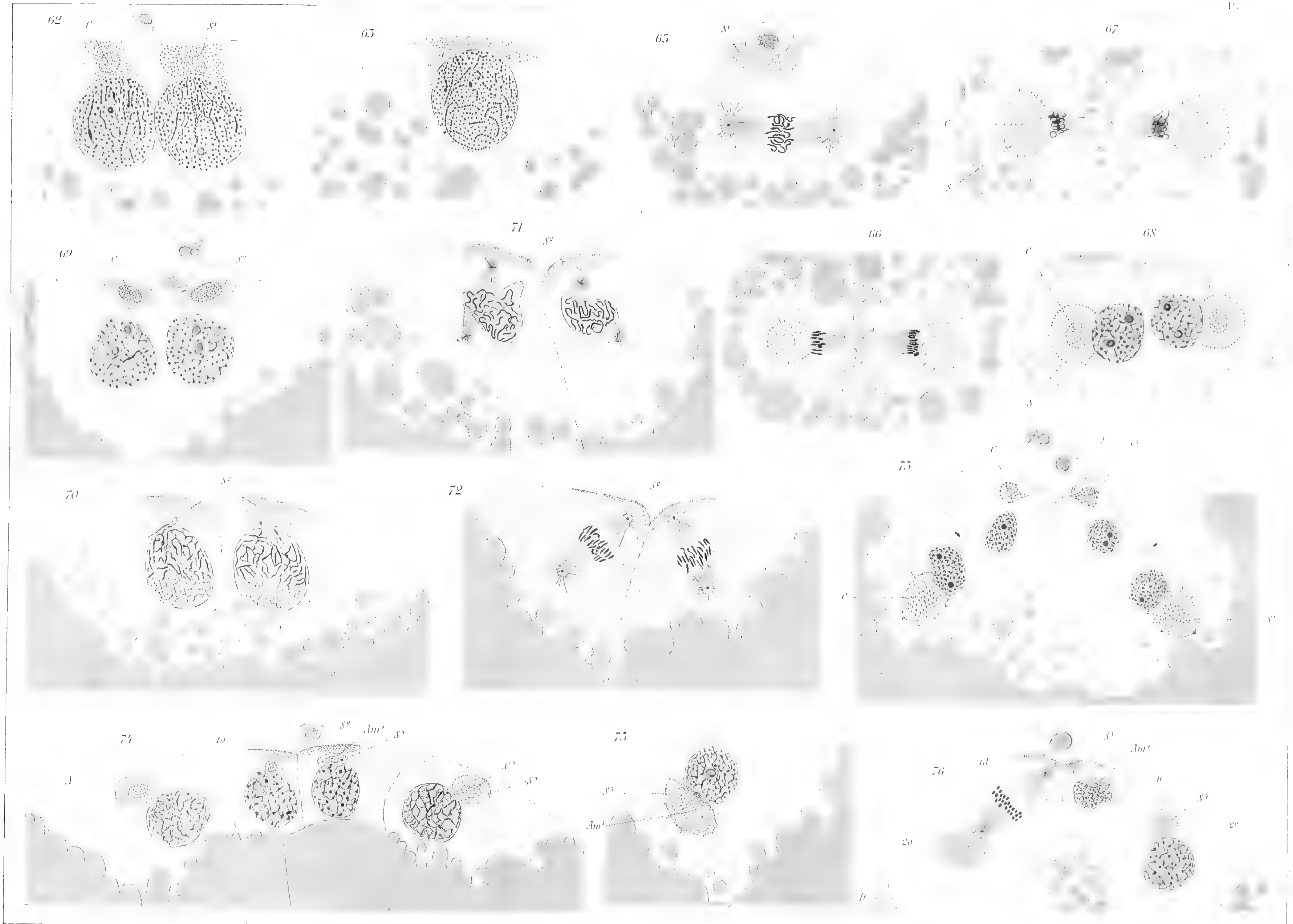

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Plate V.

Entire Eggs of C. plana; one to four cells.

All the figures on Plates V and VI were drawn at the stage level under Zeiss Apochromat Obj. 3 mm., Occ. 4.

Fig. 77.—Entire egg showing in optical action sperm nucleus and sphere approaching egg nucleus, also accessory asters and yolk lobe. There is a single nucleolus in each germ nucleus.

Fig. 78.—Contact of germ nuclei and fusion of spheres.

Fig. 79.—Anaphase of first cleavage viewed from animal pole. The fused spheres lie above the spindle and the polar bodies above the spheres.

Fig. 80.—Early telophase of first cleavage, showing dual nuclei, equatorial constriction of egg, yolk lobe and early bending of spindle axis.

Fig. 81.—Late telophase of first cleavage, showing dual nuclei and extensive bending of spindle axis.

Fig. 82.—Two cell stage from animal pole; spheres and centrosomes lie above nuclei. In right blastomere centrosome has given rise to new initial spindle.

Fig. 83.—Early prophase of second cleavage; sphere remnants lie close to polar bodies; initial spindle at outer and upper side of nucleus in position of groove between the egg and sperm halves.

Fig. 84.—Metaphase of second cleavage; sphere remnants of first cleavage beneath polar bodies; spindles at outer sides of old nuclei; outlines of the latter still preserved.

Fig. 85.—Anaphase of second cleavage; equatorial constriction beginning as a depression beneath polar bodies; the margins of this depression are raised into many pointed processes.

Fig. 86.—Late telophase of second cleavage; bending of spindle axis shown by relative positions of mid-bodies, nuclei and centrosomes; dual nuclei.

Fig. 87.—Resting 4-cell stage; spheres in the apical angles of the cells; centrosomes not visible.

Fig. 88.—Prophase of the third cleavage; sphere remnants as in preceding figure; the spindle axes lie in various directions in the different cells; the nuclear outlines still indicated, also the escape of nuclear sap into the spheres.

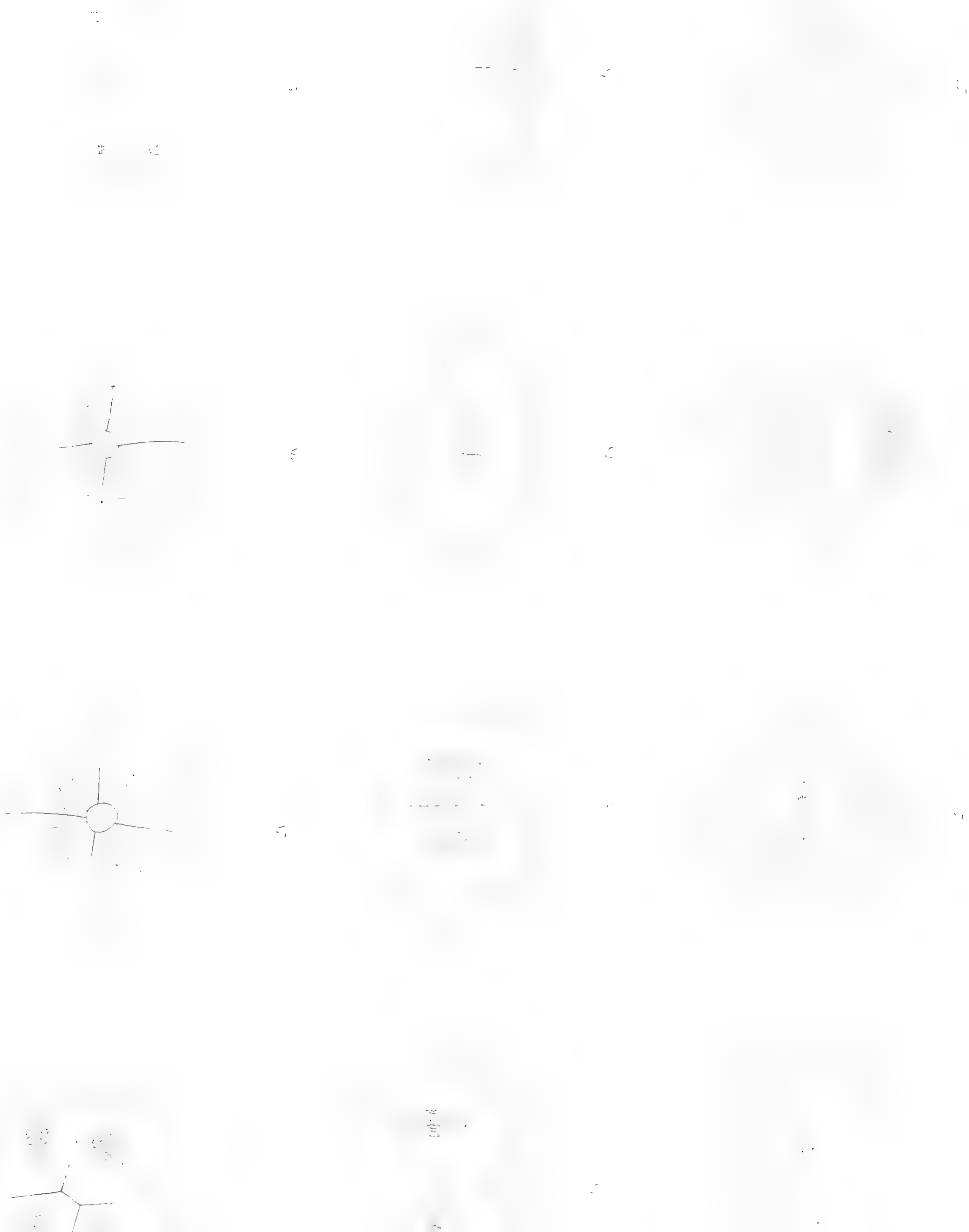


Plate VI.

Entire Eggs of C. plana; four to forty-five cells.

(The figures of this plate are oriented as in the preceding one, the first cleavage furrow running from top to bottom, the second from left to right; the left lower quadrant is A, the left upper B, the right upper C, and the right lower D.)

Fig. 89.—Metaphase of third cleavage; spindles in definitive positions, second cleavage sphere remnants still preserved at apical angles of cells.

Fig. 90.—Anaphase and telophase of third cleavage; rotation of cell contents and bending of spindle axes beginning; second cleavage sphere remnants still preserved; dual nuclei.

Fig. 91.—Resting 8-cell stage; rotation of cell contents and bending of spindle axes indicated by relative positions of yolk, cytoplasm, mid-bodies, nuclei and centrosomes; the latter are chromatic and elliptical or spindle shaped.

Fig. 92.—Fourth cleavage and formation of second quartette; third cleavage sphere remnants at extreme left of each macromere, where they are spread into a broad ring by the upper pole of the spindle; centrosomes in micromeres spindle-shaped.

Fig. 93.—Telophase of fourth cleavage of macromeres; prophase of first division of first quartette; the mitotic figure in one of these micromeres (1a) has already begun to move from an apical to a peripheral position in the cell.

Fig. 94.—Slightly later stage than the preceding showing the extensive bending of the spindle axes in the second quartette cells. Three of the first quartette cells are in the metaphase, their spindles being in their definitive positions, the nucleus of the fourth (1d) is still in the apical angle of the cell; sphere remnants still lie in apical angles.

Fig. 95.—Later stage than preceding showing still greater bending of the spindle axes of the second quartette cells. In the first quartette three cells are in the anaphase, one in the metaphase; third cleavage sphere remnants still preserved.

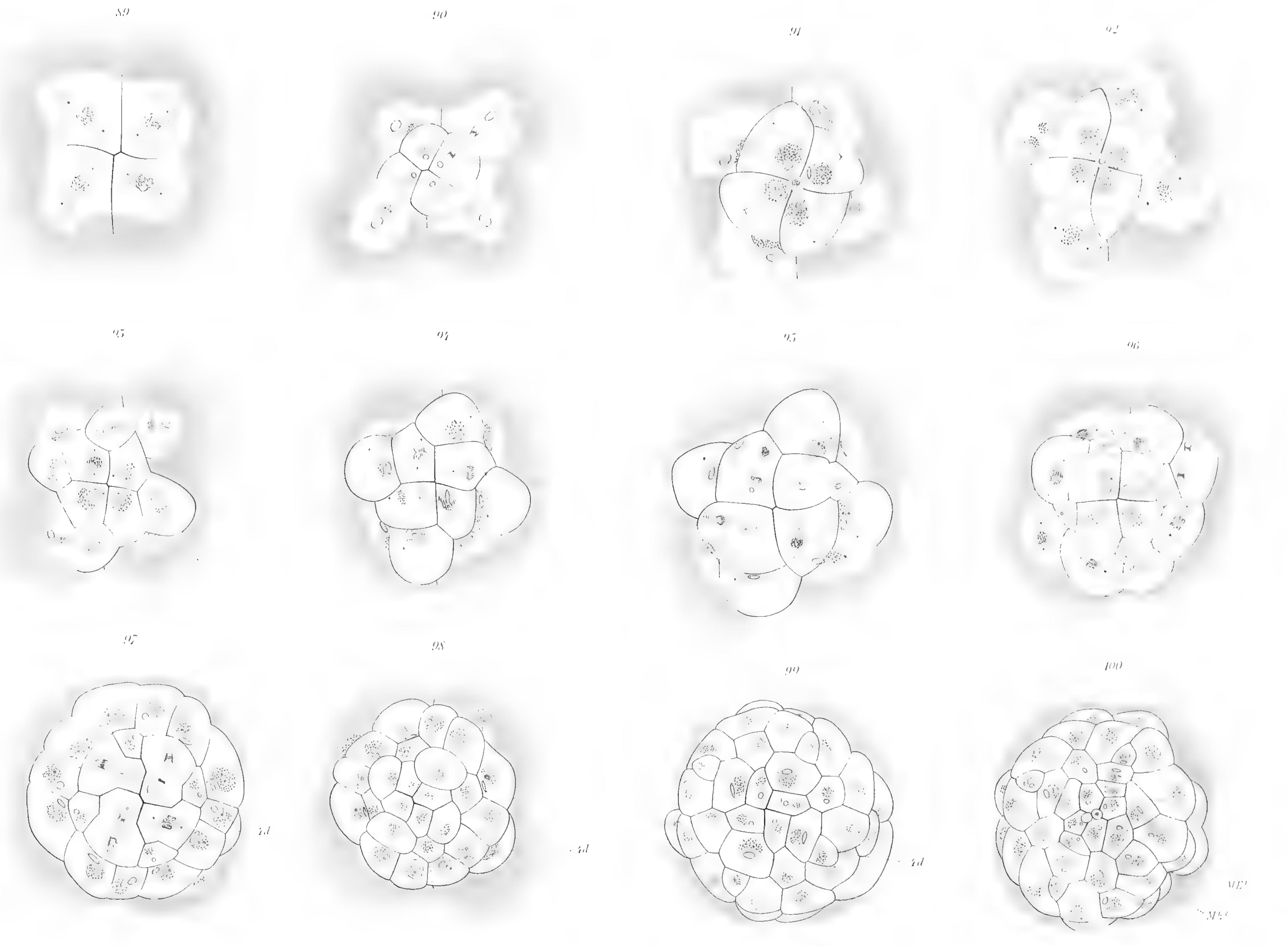
Fig. 96.—Formation of third quartette; subdivision of second quartette, the sphere remnants in these cells going into one daughter cell only (the right one) and not into the other; telophase in division of first quartette, the nuclei showing dual character.

Fig. 97.—Second division of first quartette; the division in three of these cells (1a, 1b, 1c) is unequal, in the fourth (1d) it is nearly equal and is always later than in the others. The extensive rotations in the daughter cells of the second quartette is indicated by the bending of the spindle axes. The mesentoblast (4d) already formed.

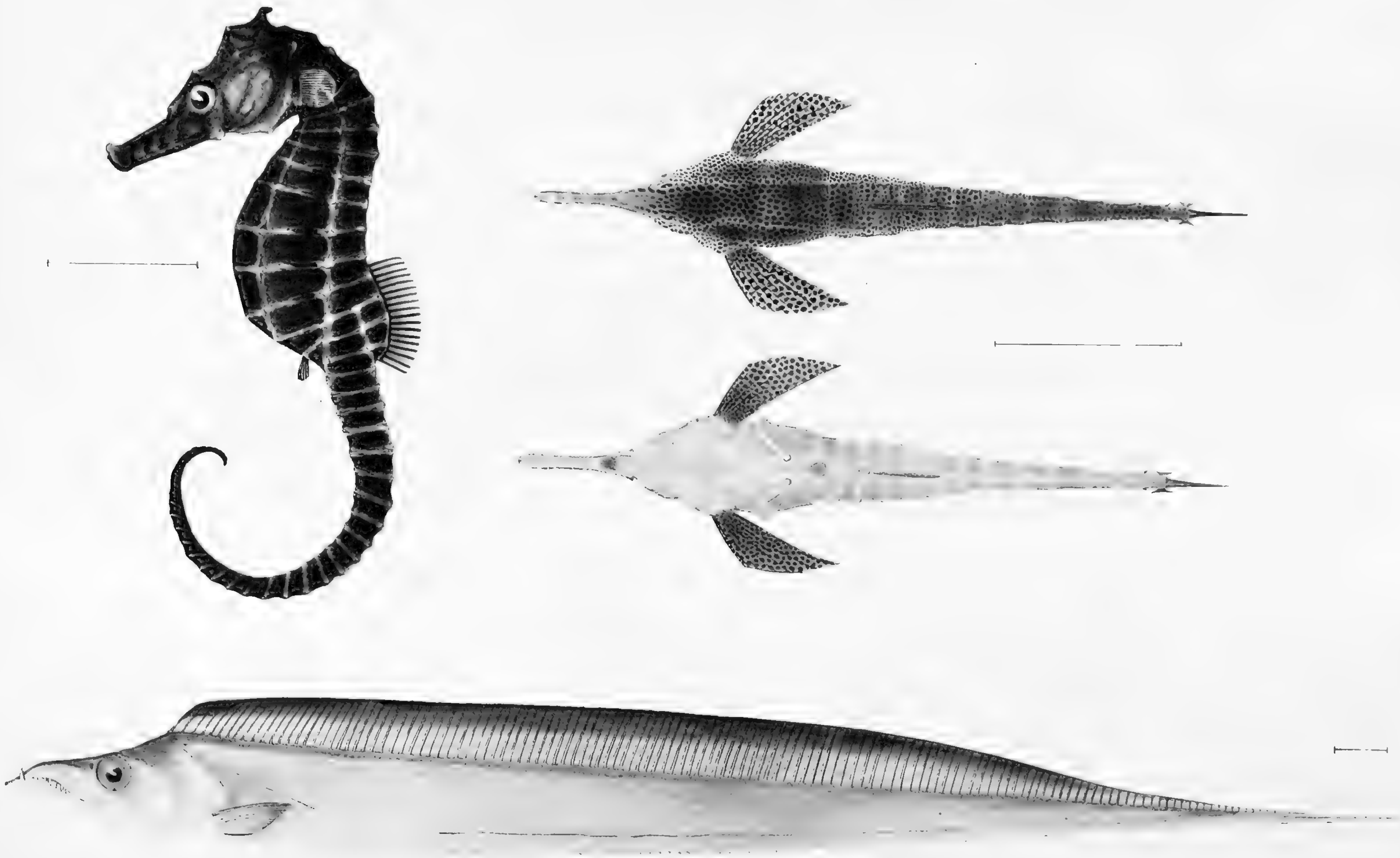
Fig. 98.—Resting 29-cell stage; the extensive bending of the spindle axes in the apical cells is shown by the positions of the spheres, in the basal cells of the cross this bending is very slight. A few dual nuclei are shown.

Fig. 99.—Forty-one cells; mesentoblast (4d) dividing; the second subdivision of the second quartette cells has occurred, the right product in each quadrant giving rise to the *tip cell* of the cross; the third quartette has also divided, the direction of the division being læotropic in quadrants A, B, C and slightly dexiotropic in quadrant D.

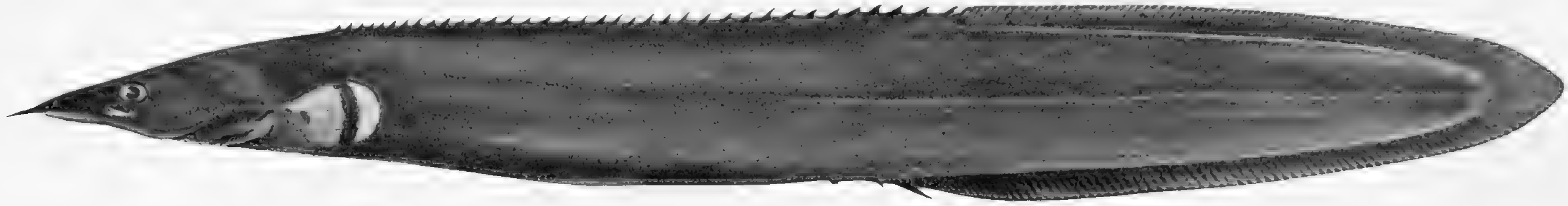
Fig. 100.—Forty-five cells; mesentoblast (4d) divided into right and left products (ME^1, ME^2); basal cells divided in three arms of the cross by a reversed cleavage; the basal cell in the fourth arm (posterior one) still undivided; dual nuclei are shown in the tip cells.

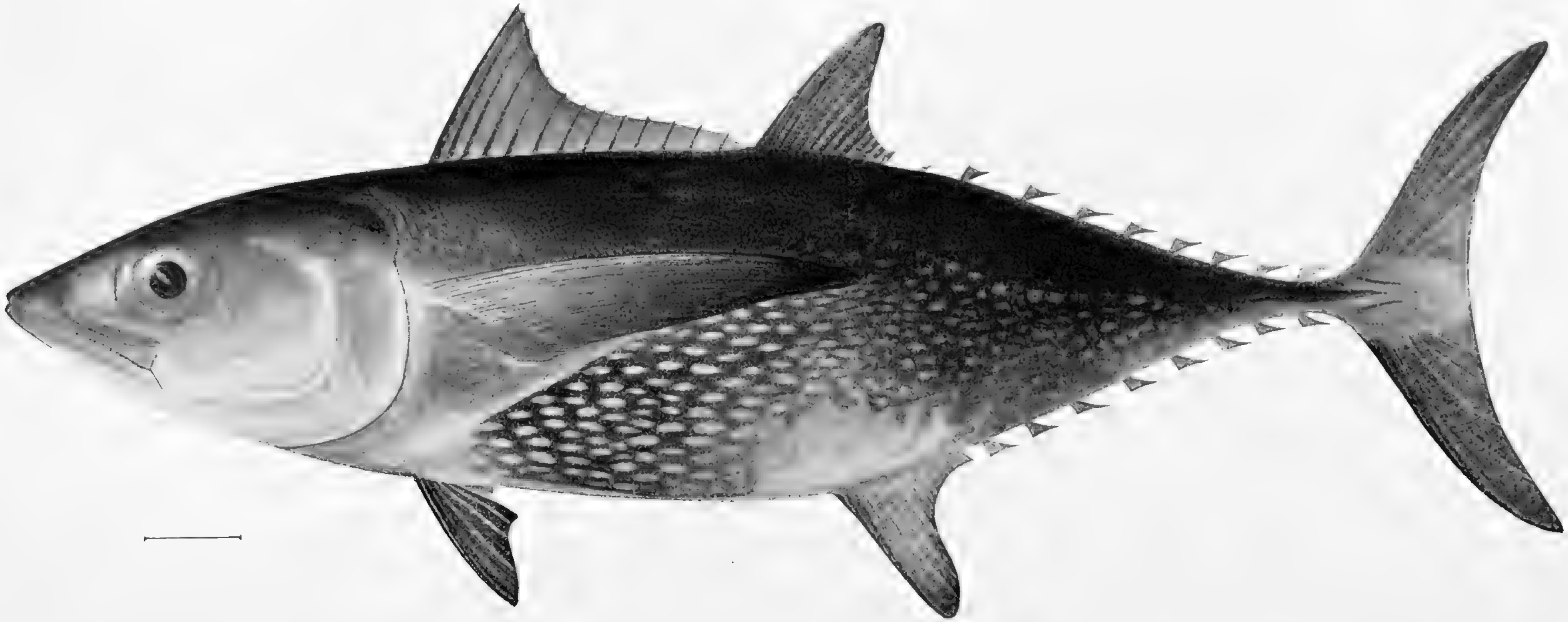


CONKLIN. Karyokinesis and Cytokinesis.

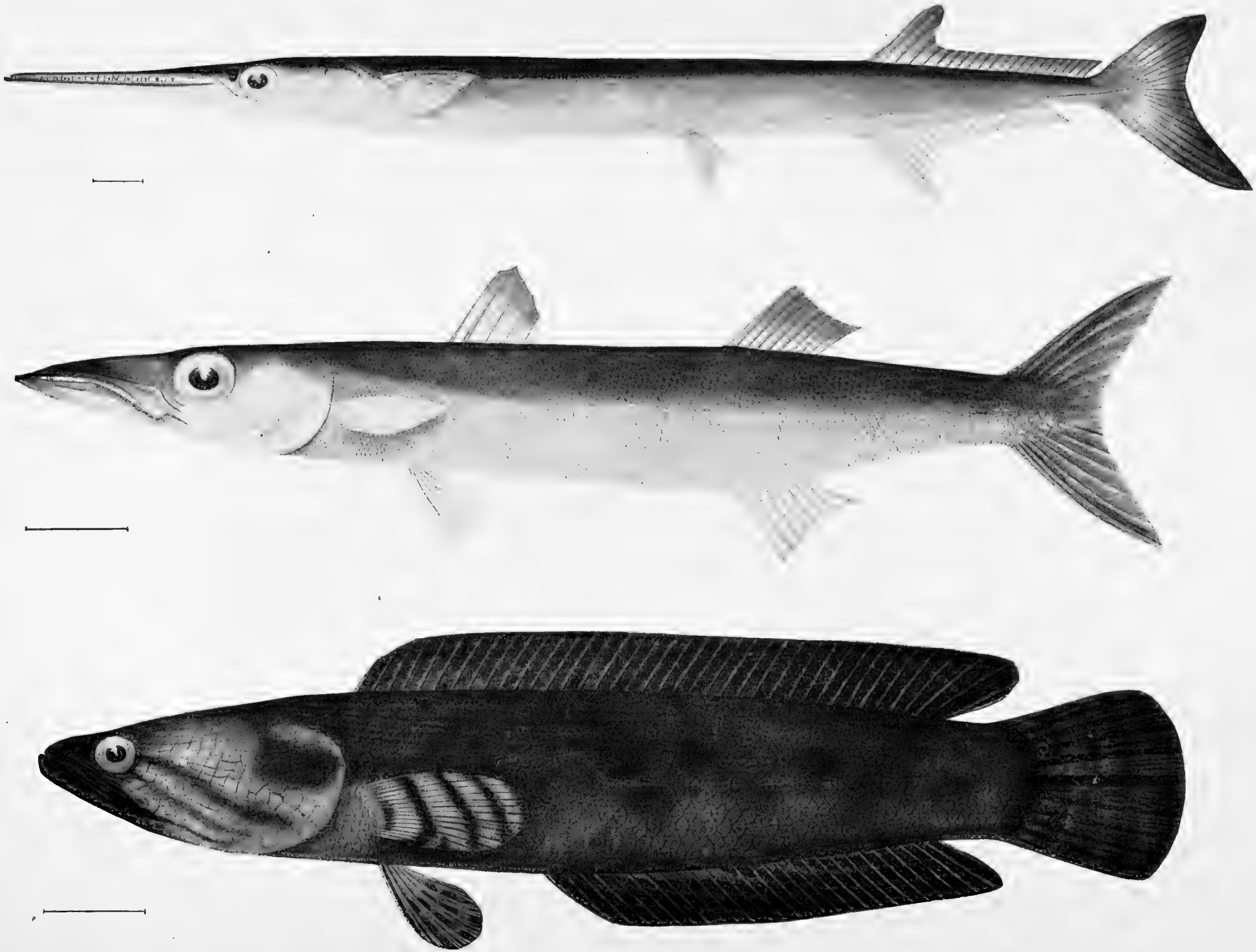


HIPPOCAMPUS TÆNIOPS FOWLER. PARAPEGASUS NATANS (LINNÆUS).
TRICHIURUS HAUMELA (FORSKÅL).

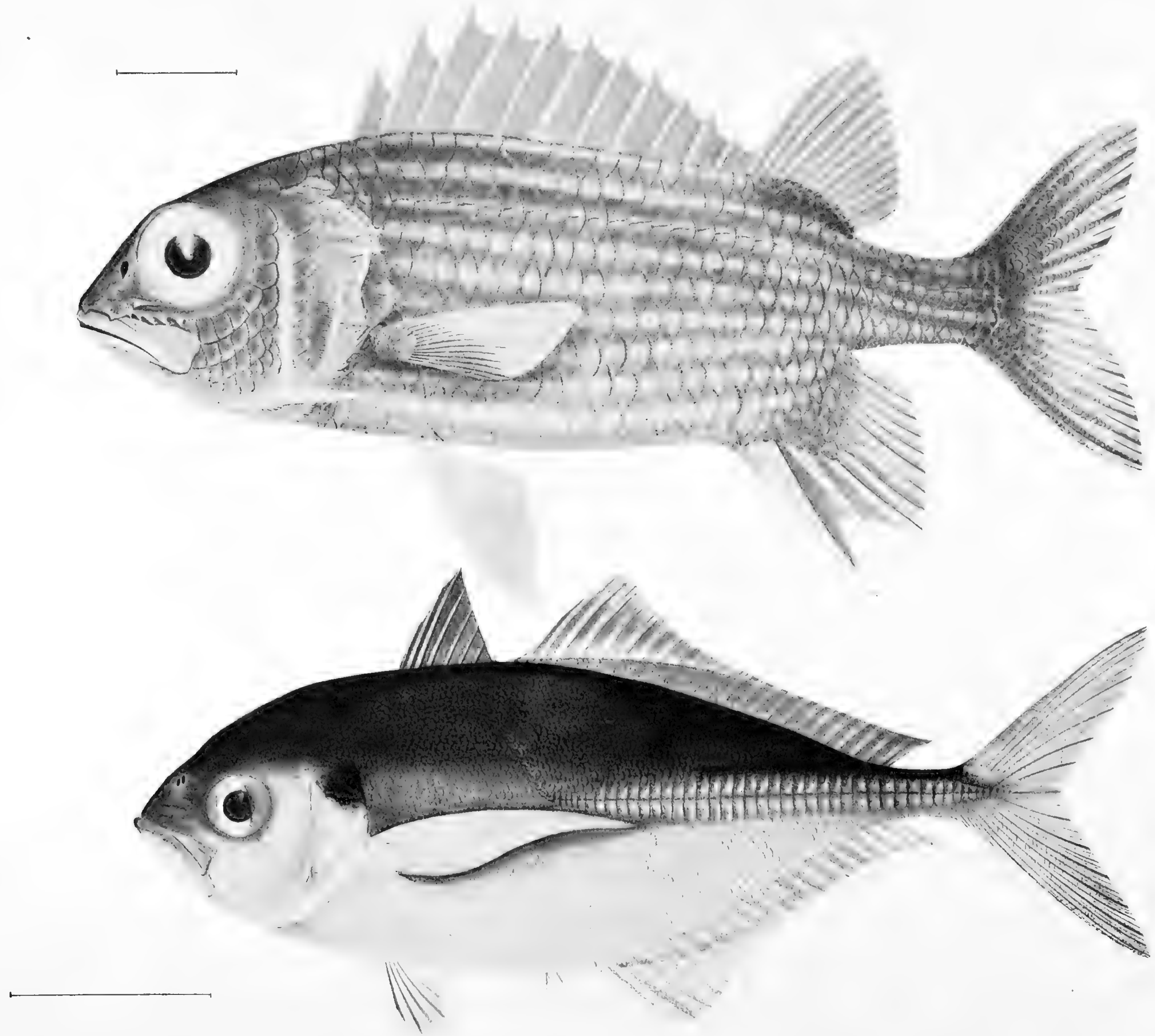




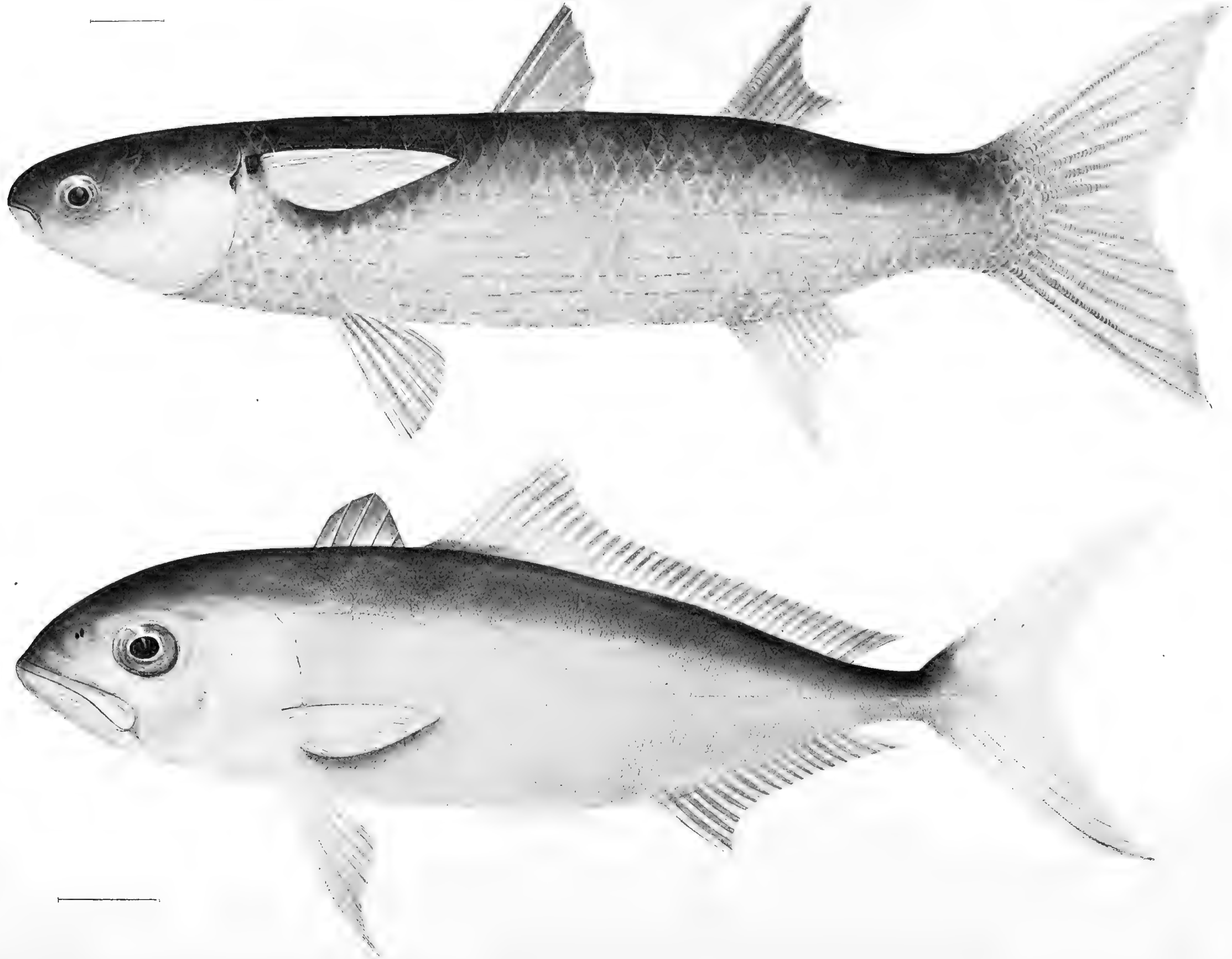
MASTACEMBELUS UNICOLOR VALENCIENNES.
GERMO GERMON (LACÉPÈDE).



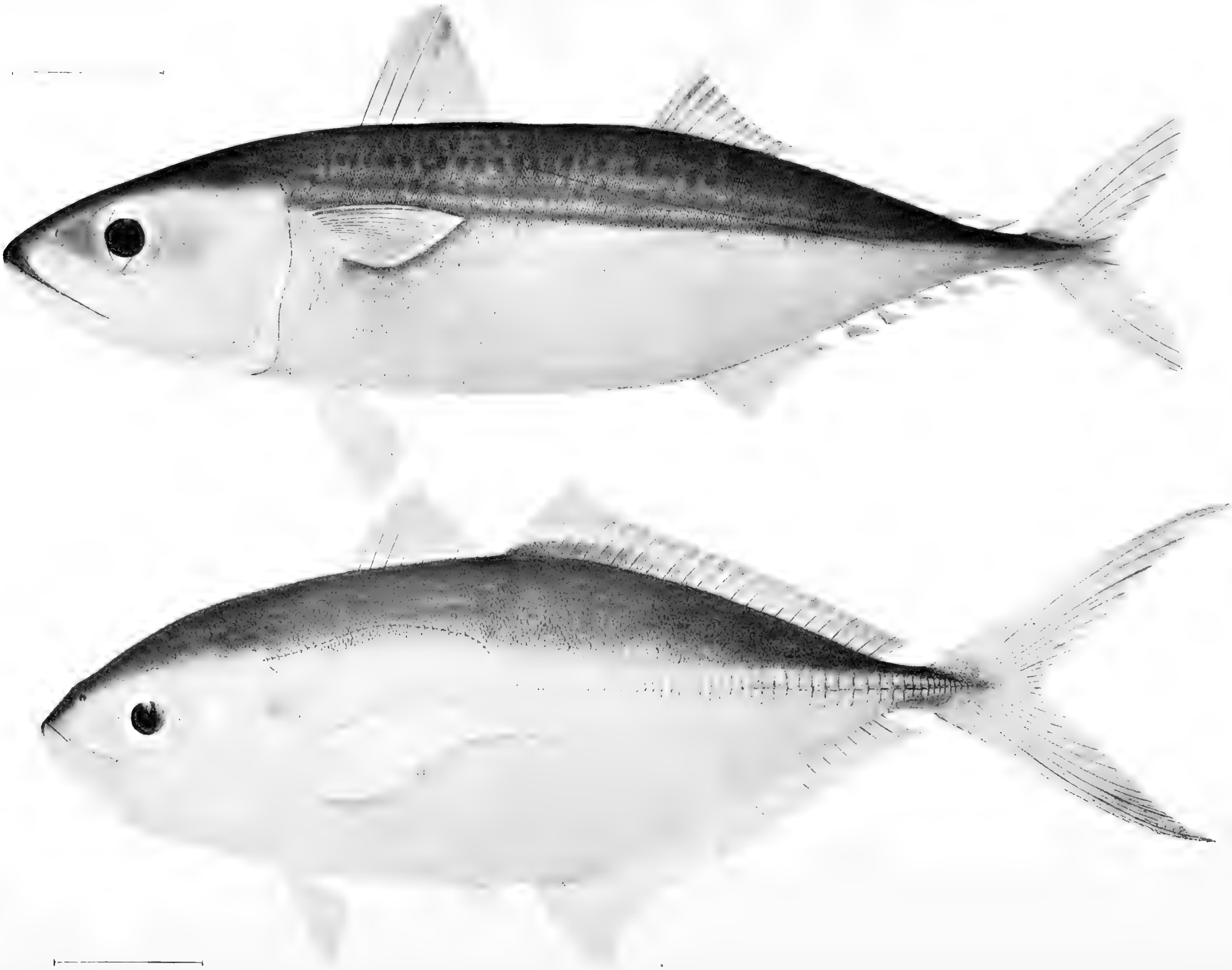
TYLOSURUS CROCODILUS (LESUEUR).
SPHYRÆNA TOXEUMA FOWLER.
OPHICEPHALUS SPIRITALIS FOWLER.



HOLOCENTHRUS AUREORUBER FOWLER.
ALEPES SCITULA FOWLER.

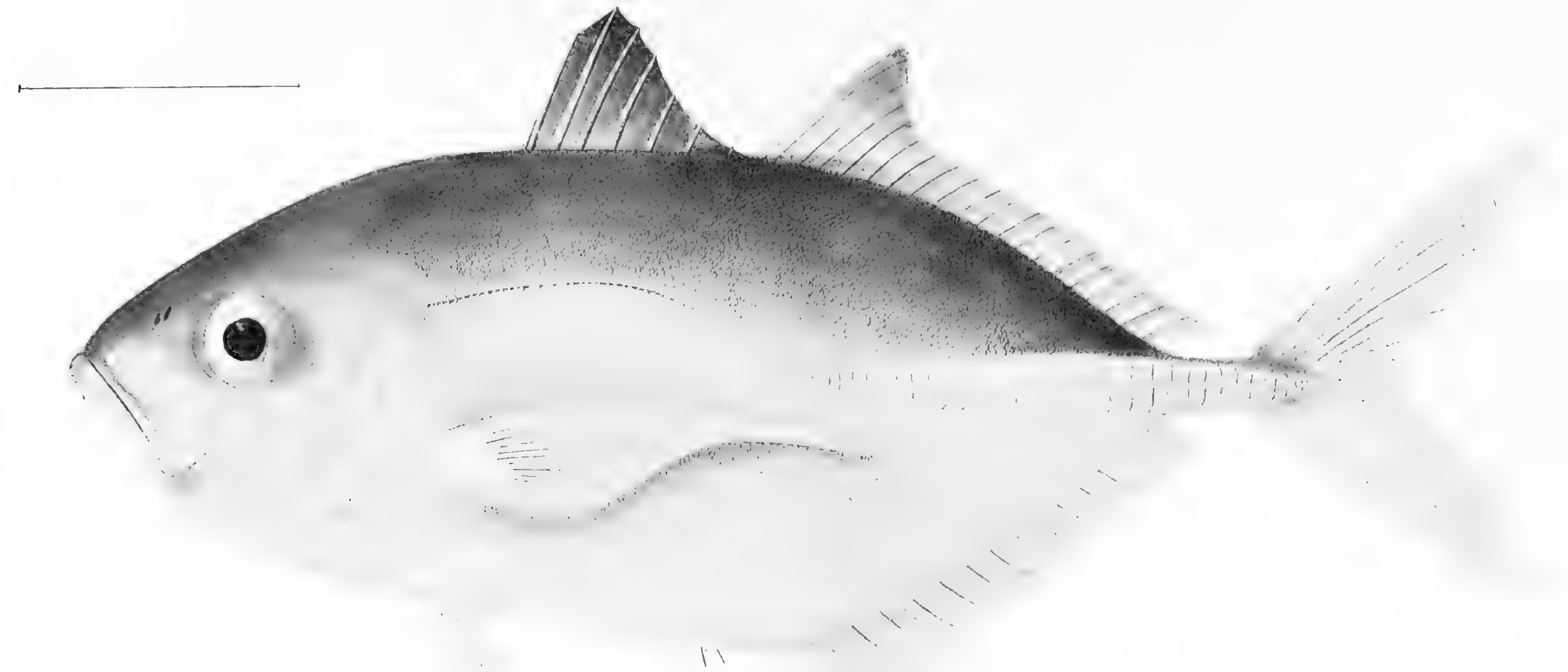


LIZA CÆRULEOMACULATA (LACÉPÈDE).
SERIOLA CRETATA FOWLER.



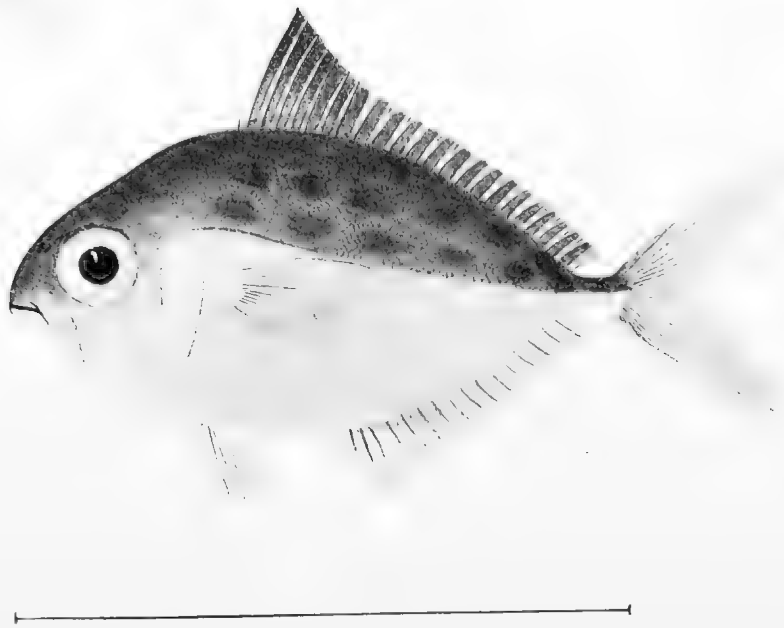
SCOMBER KANAGURTA RÜPPELL.
ALEPES GLABRA FOWLER.

CARANX MEGALASPIS (BLEEKER).
CARANX MATE VALENCIENNES.

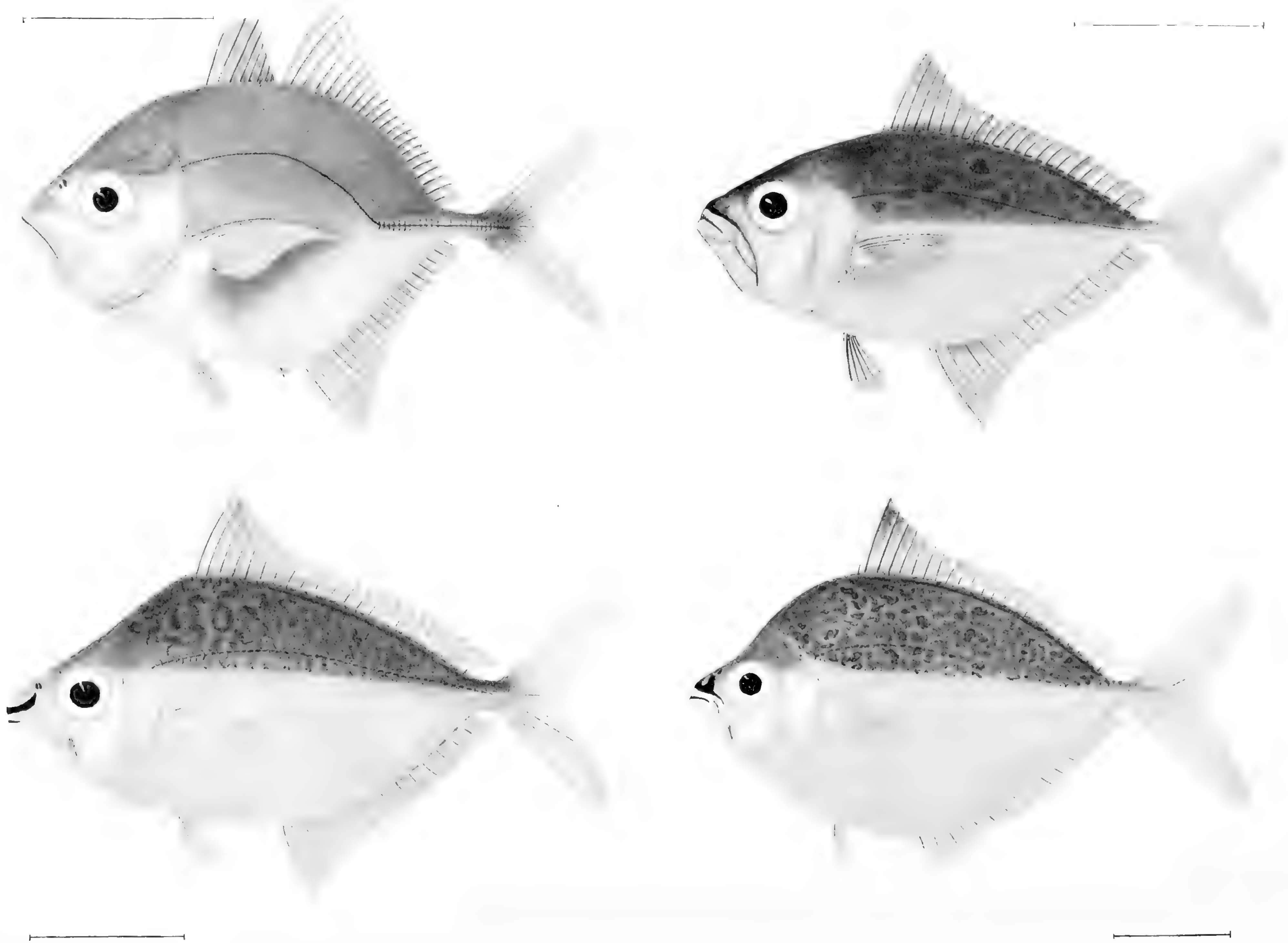


CARANX SEM VALENCIENNES.

CITULA ATROPOS (SCHNEIDER).

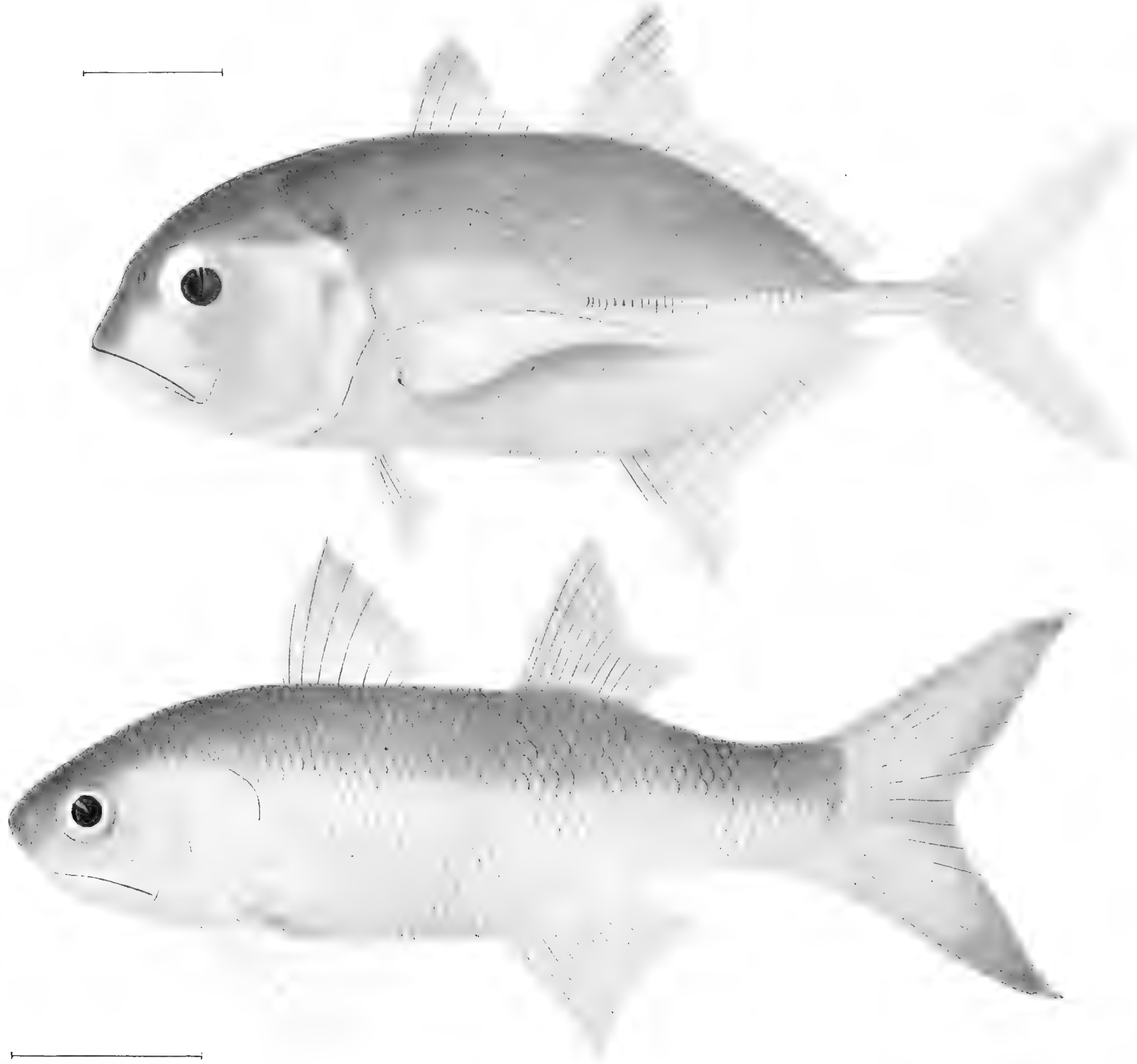


LEIOGNATHUS SPILOTUS FOWLER.

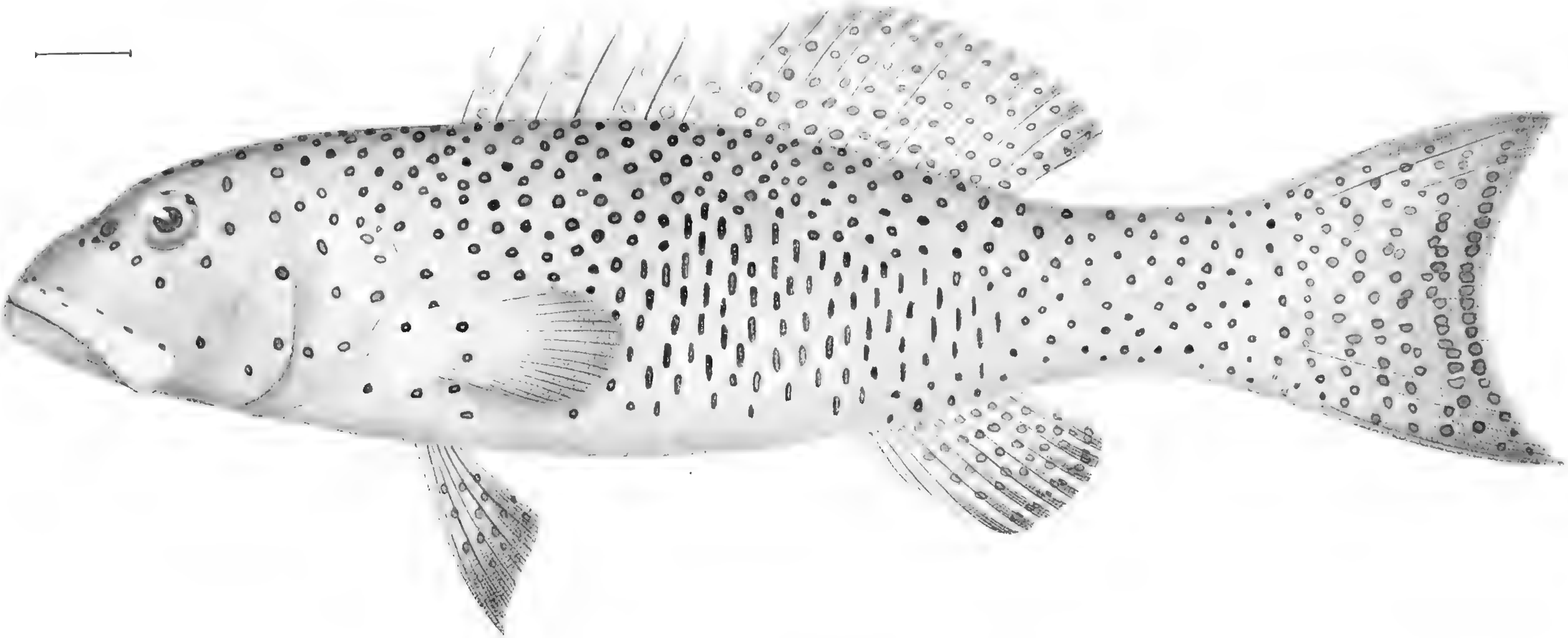


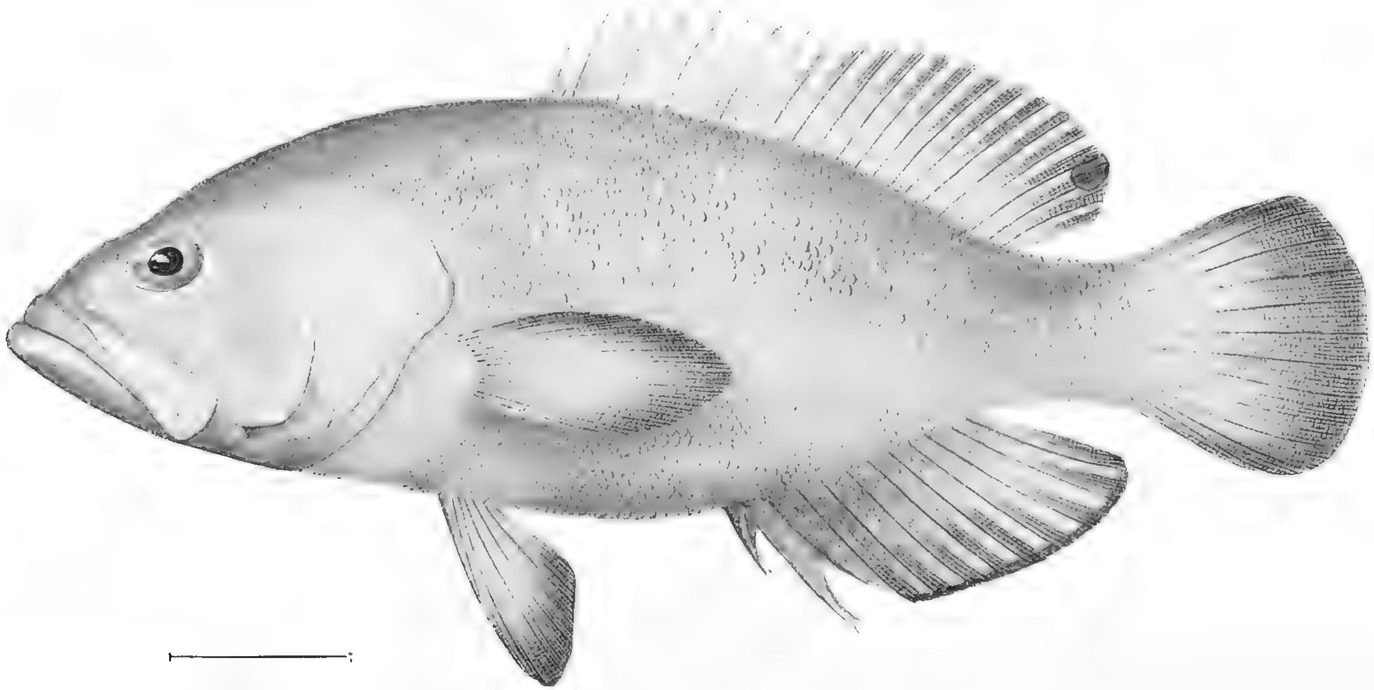
CARANGOIDES GIBBER FOWLER.
LEIOGNATHUS VERMICULATUS FOWLER.

GAZZA TAPEINOSOMA BLEEKER.
LEIOGNATHUS VIRGATUS FOWLER.

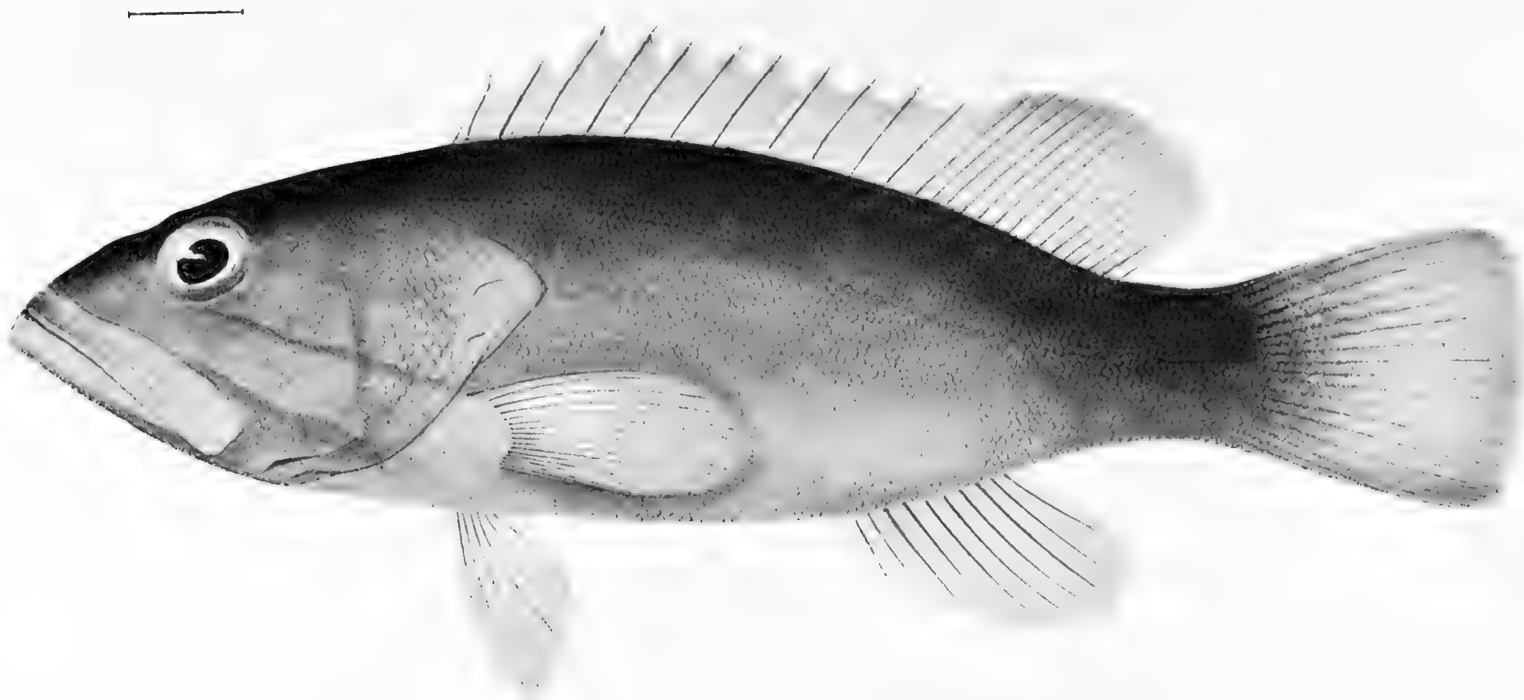


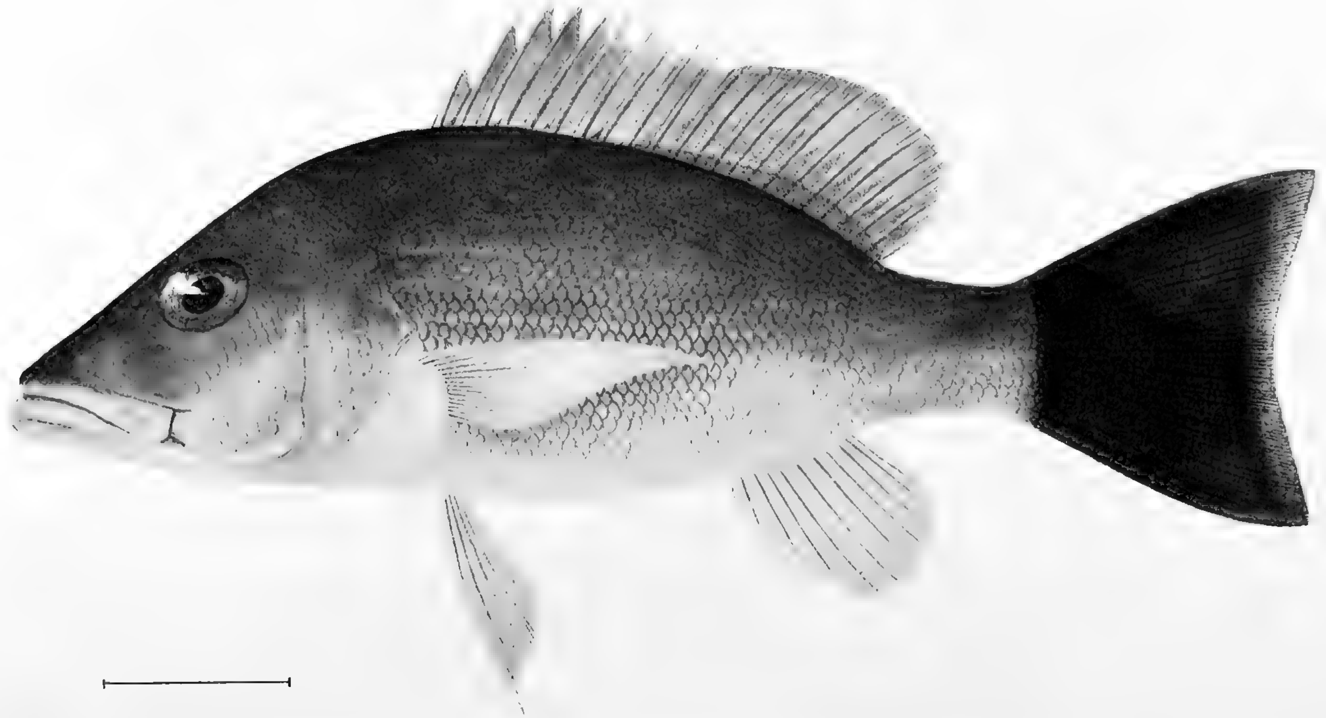
CARANX SEMISOMNUS FOWLER.
POLYDACTYLUS PFEIFFERI (BLEEKER).



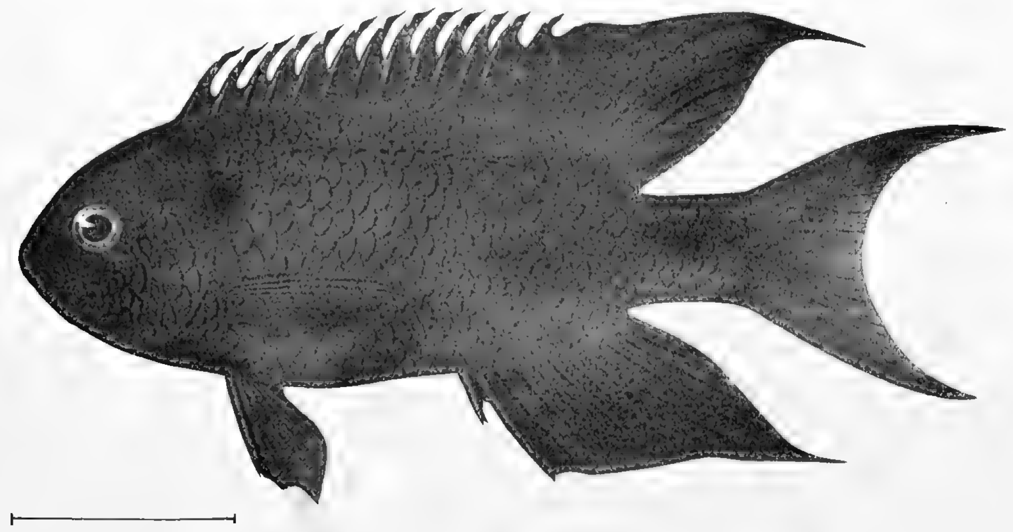


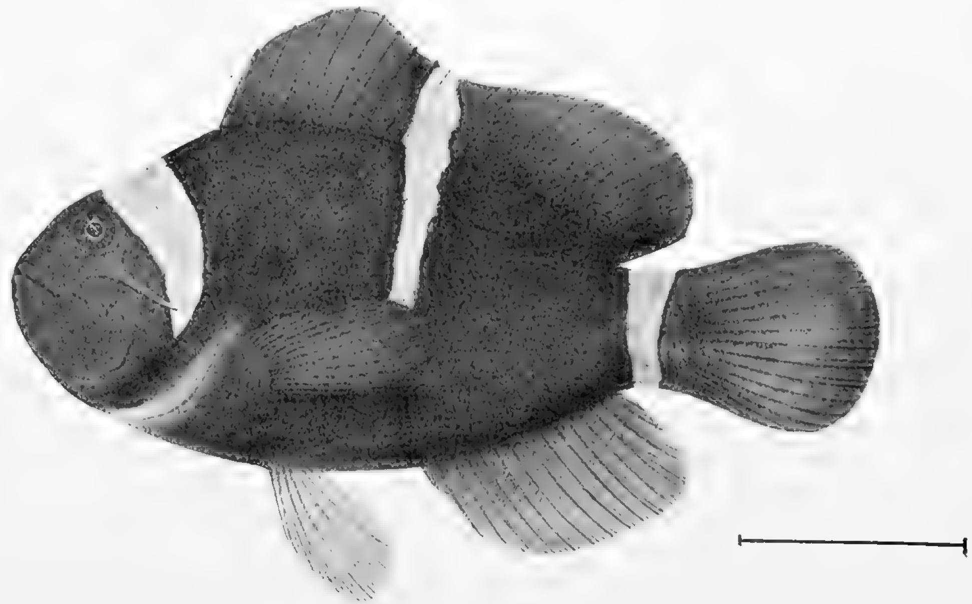
PLECTROPOMA PESSULIFERUM FOWLER.
BODIANUS INDELEBILIS FOWLER.





EPINEPHELUS HENIOCHUS FOWLER.
LUTIANUS FURVICAUDATUS FOWLER.



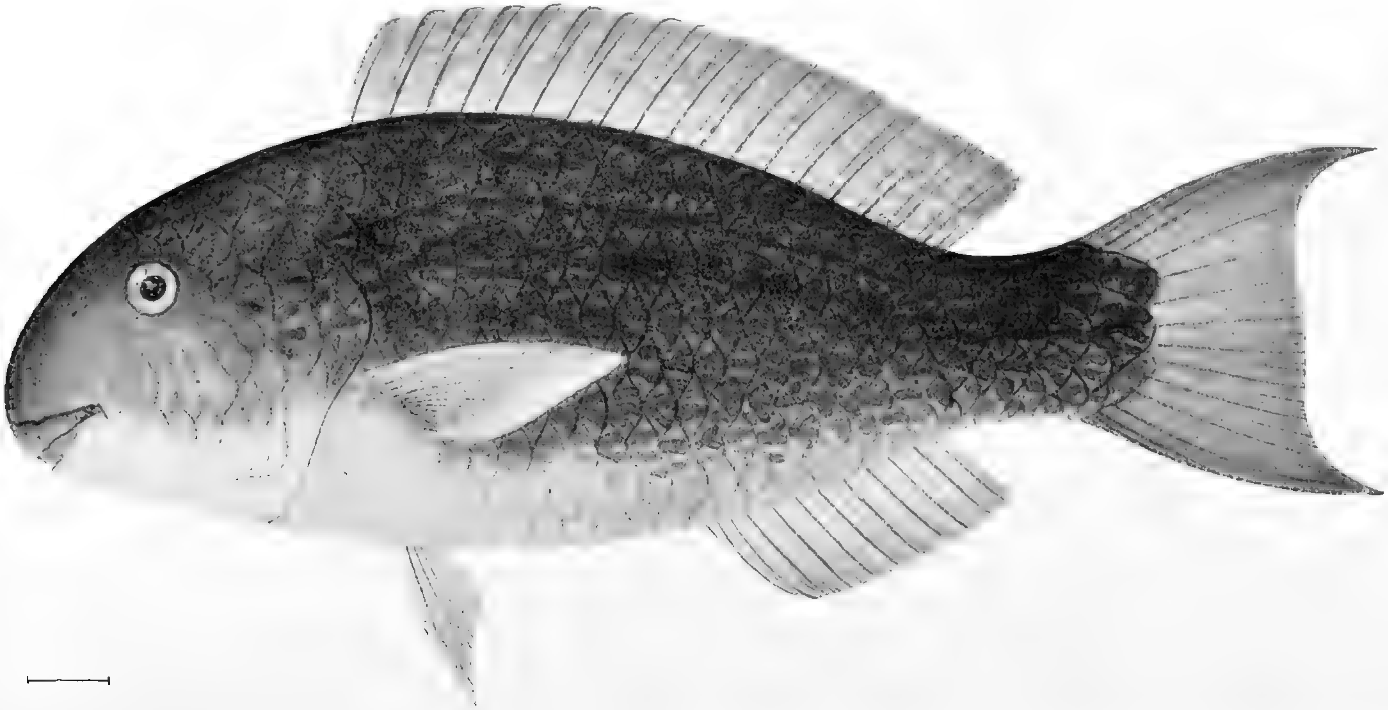


CÆSIO ERYTHROCHILURUS FOWLER.

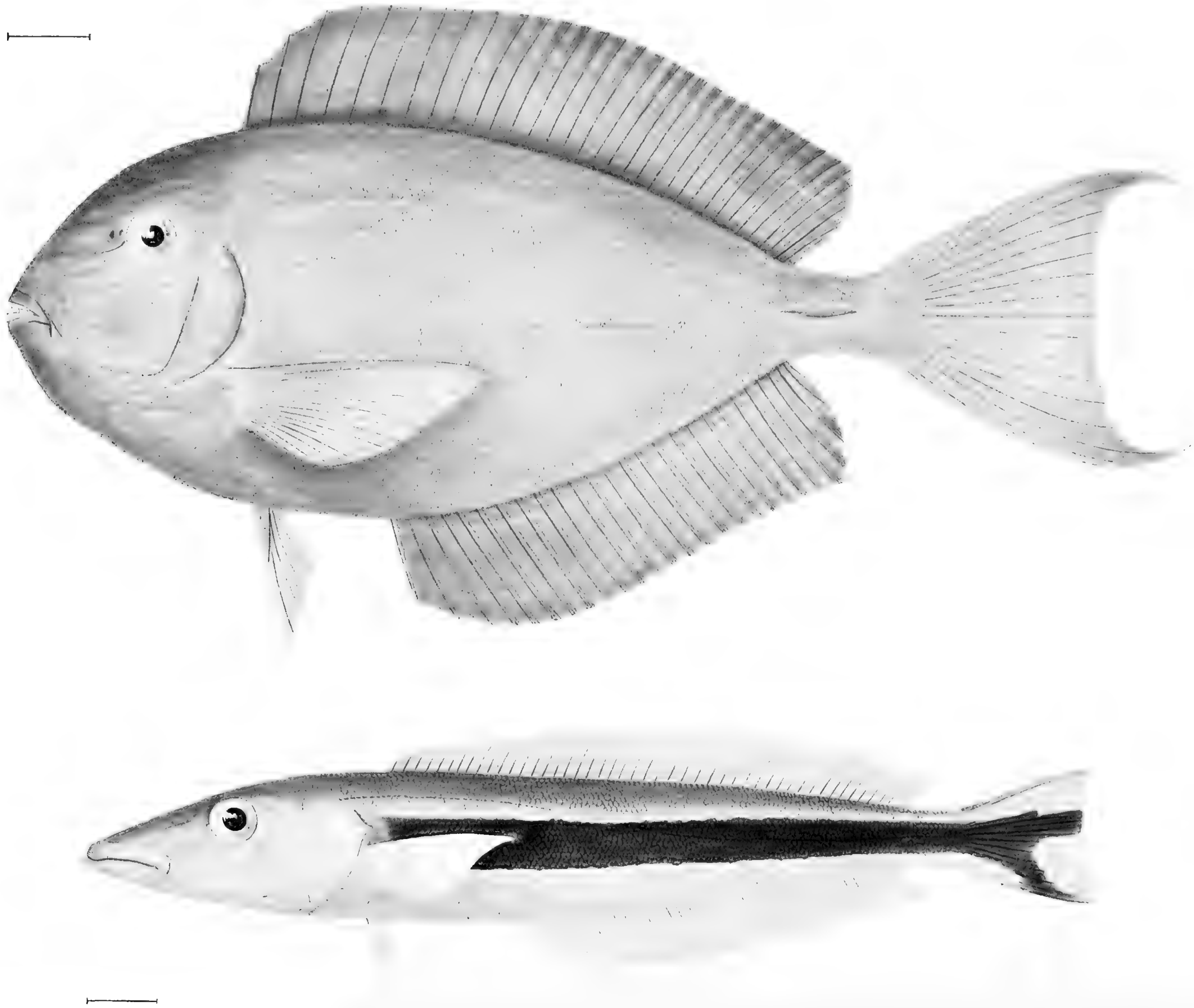
POMACENTRUS LEUCOSPHYRUS FOWLER.

PREMNAS EPIGRÁMMATA FOWLER.

HALICHŒRES ANNULATUS FOWLER.
THALASSOMA MELANOCHIR FOWLER.
HEMIPTERONOTUS LIOGENYS FOWLER.

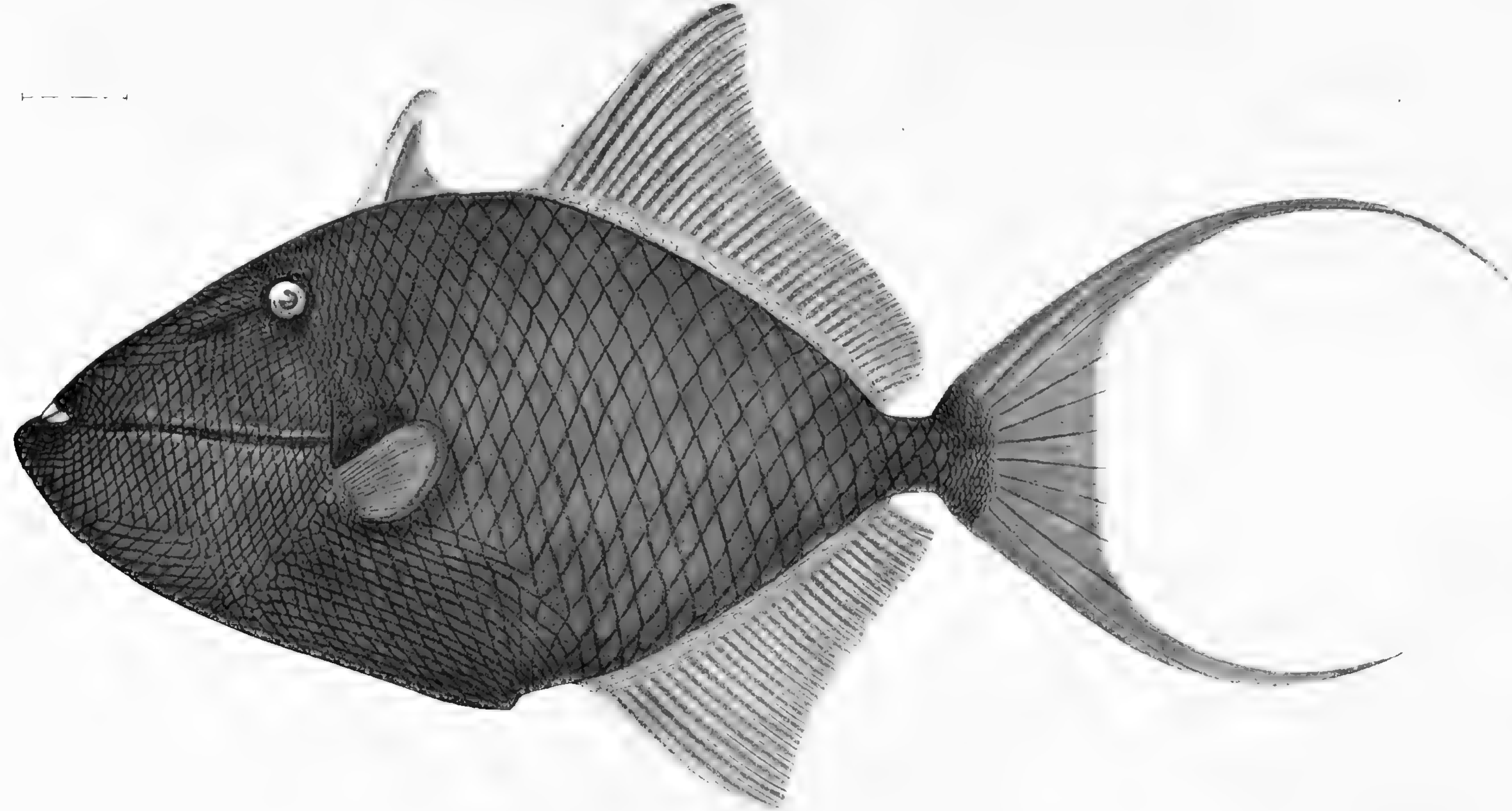


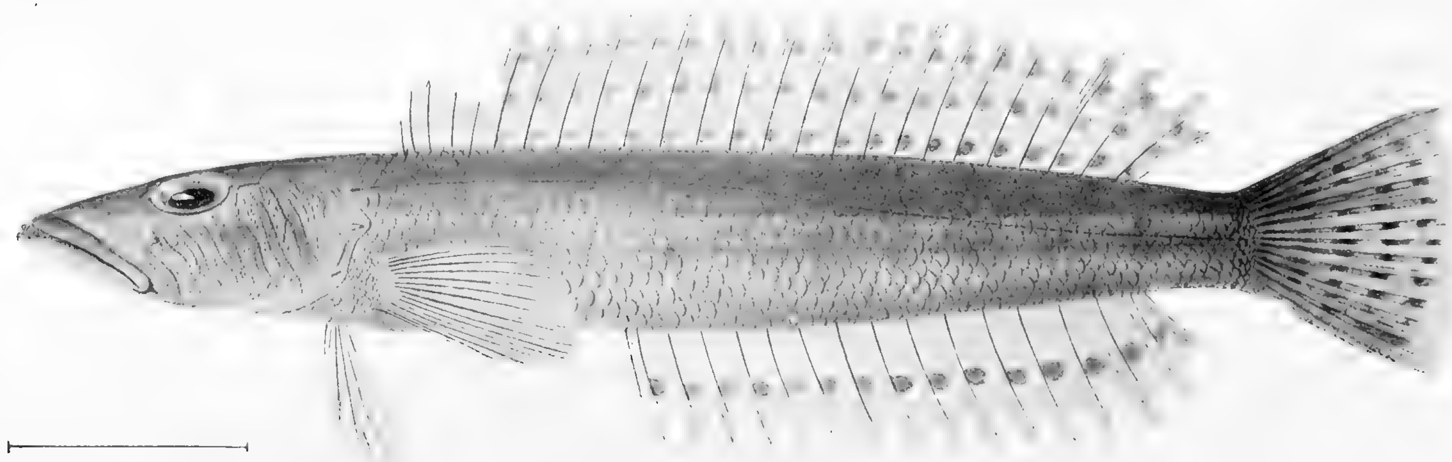
SCARUS PINGUIROSTRATUS FOWLER.
SCARUS CALUS FOWLER.



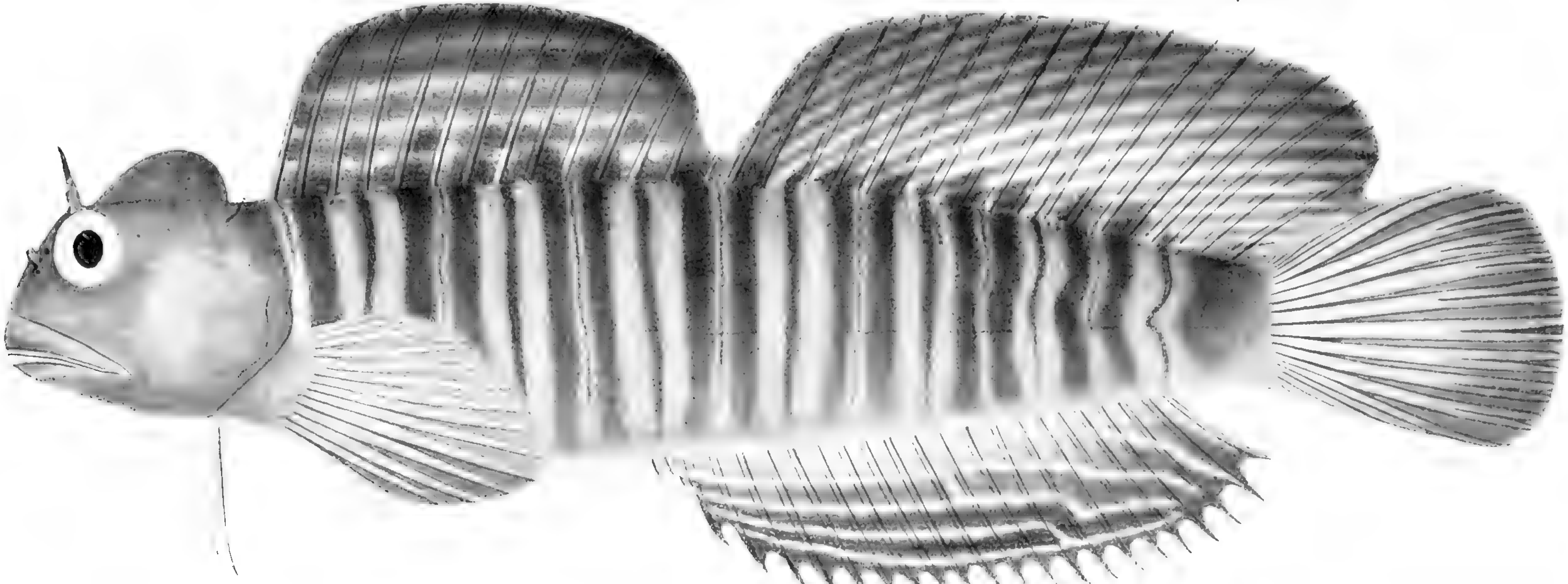
HARPURUS GNOPHODES FOWLER.
MALACANTHUS URICHTHYS FOWLER.

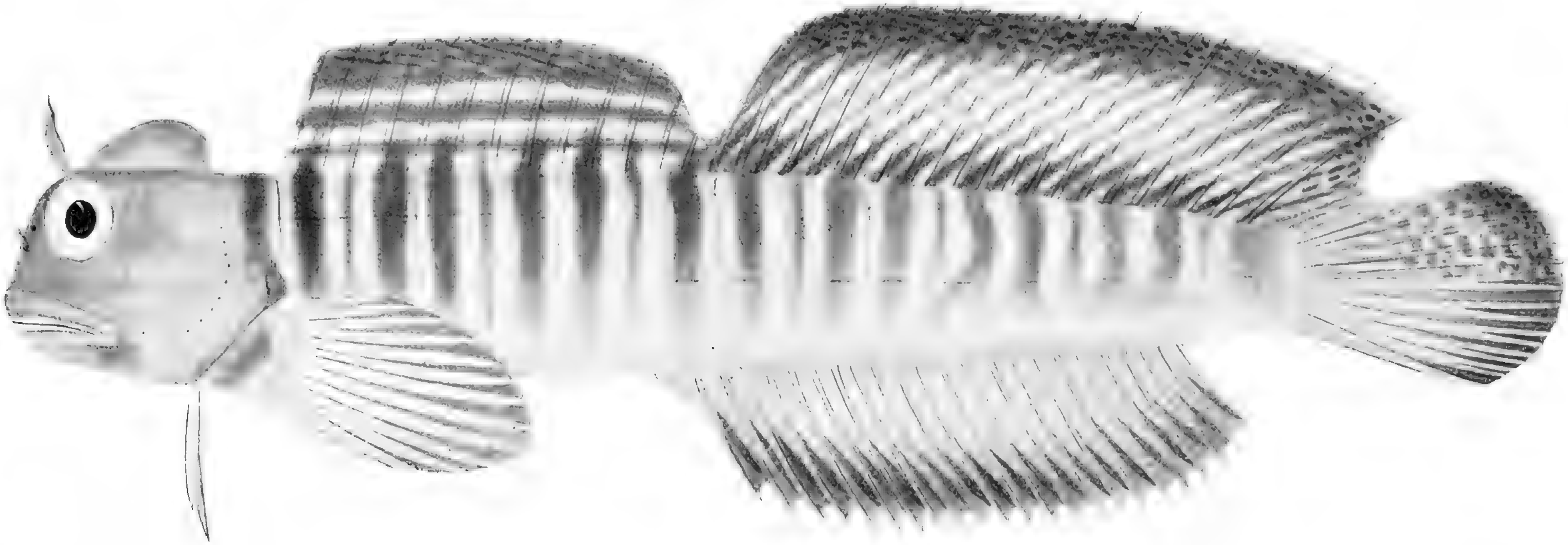
HARPOCHIRUS LONGIMANUS (SCHNEIDER).
THALASSOMA LUNARE (LINNÆUS).



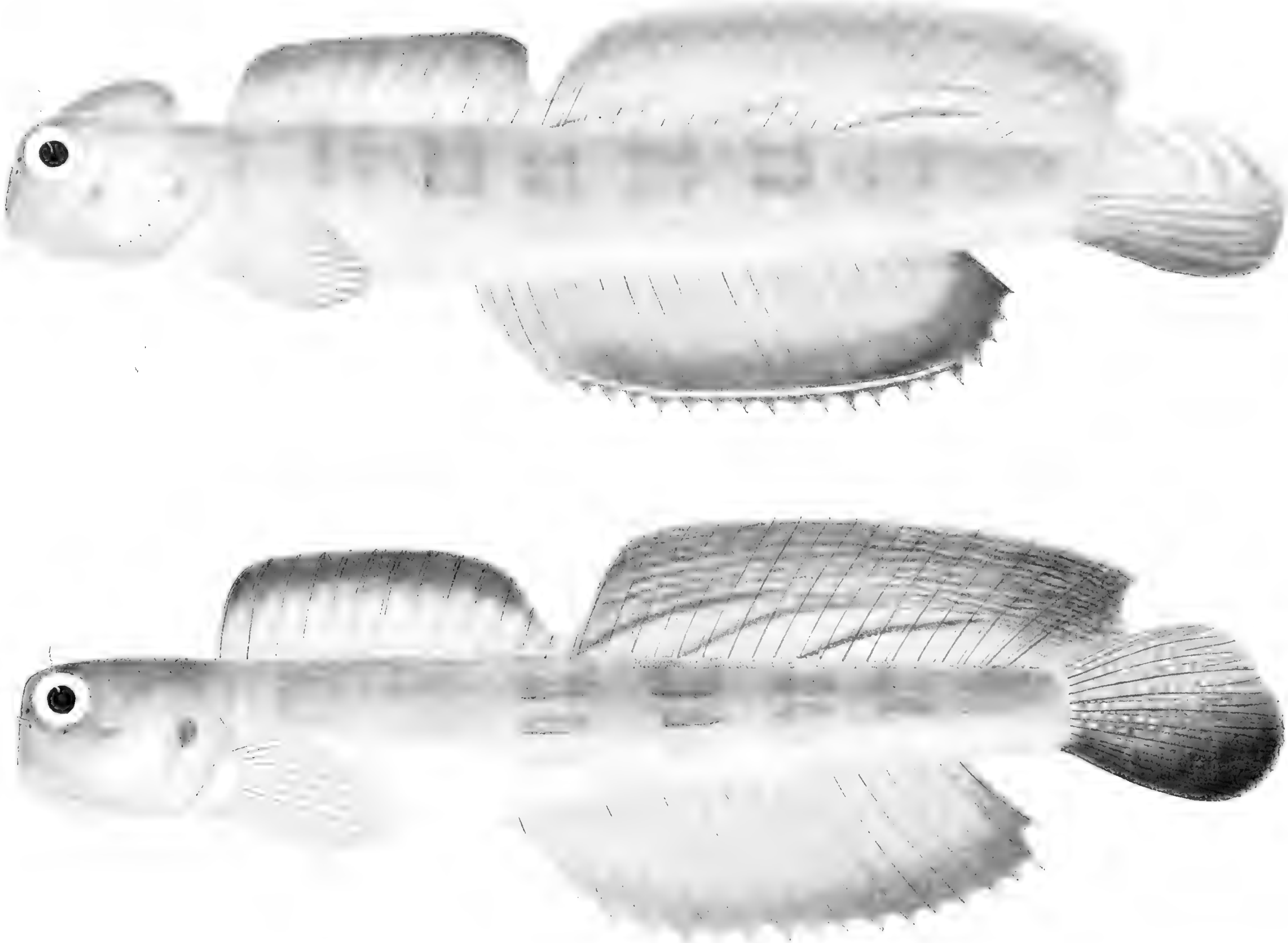


ZENODON CÆRULEOLORUM FOWLER.
PARAPERCIS ATROMACULATA FOWLER.

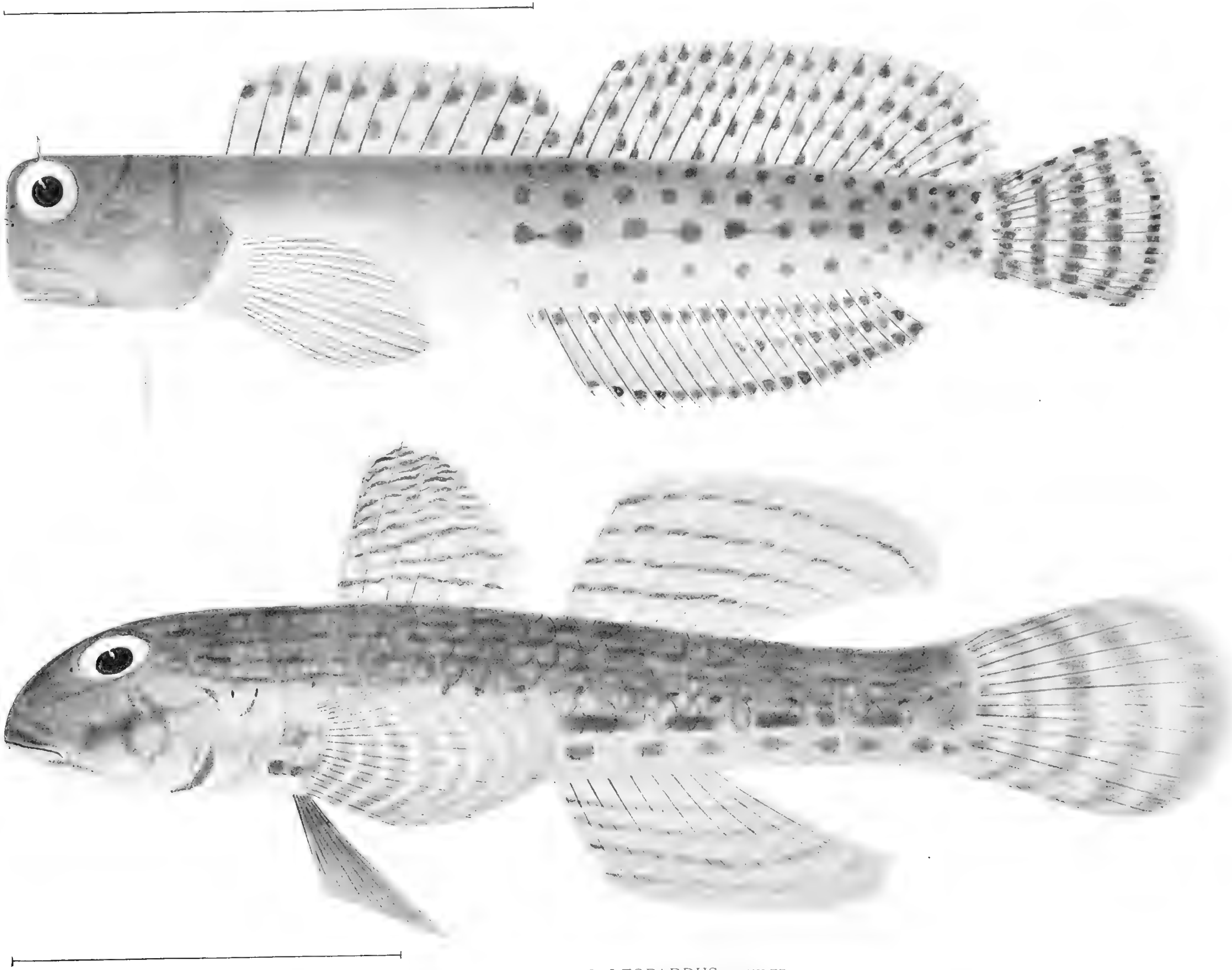




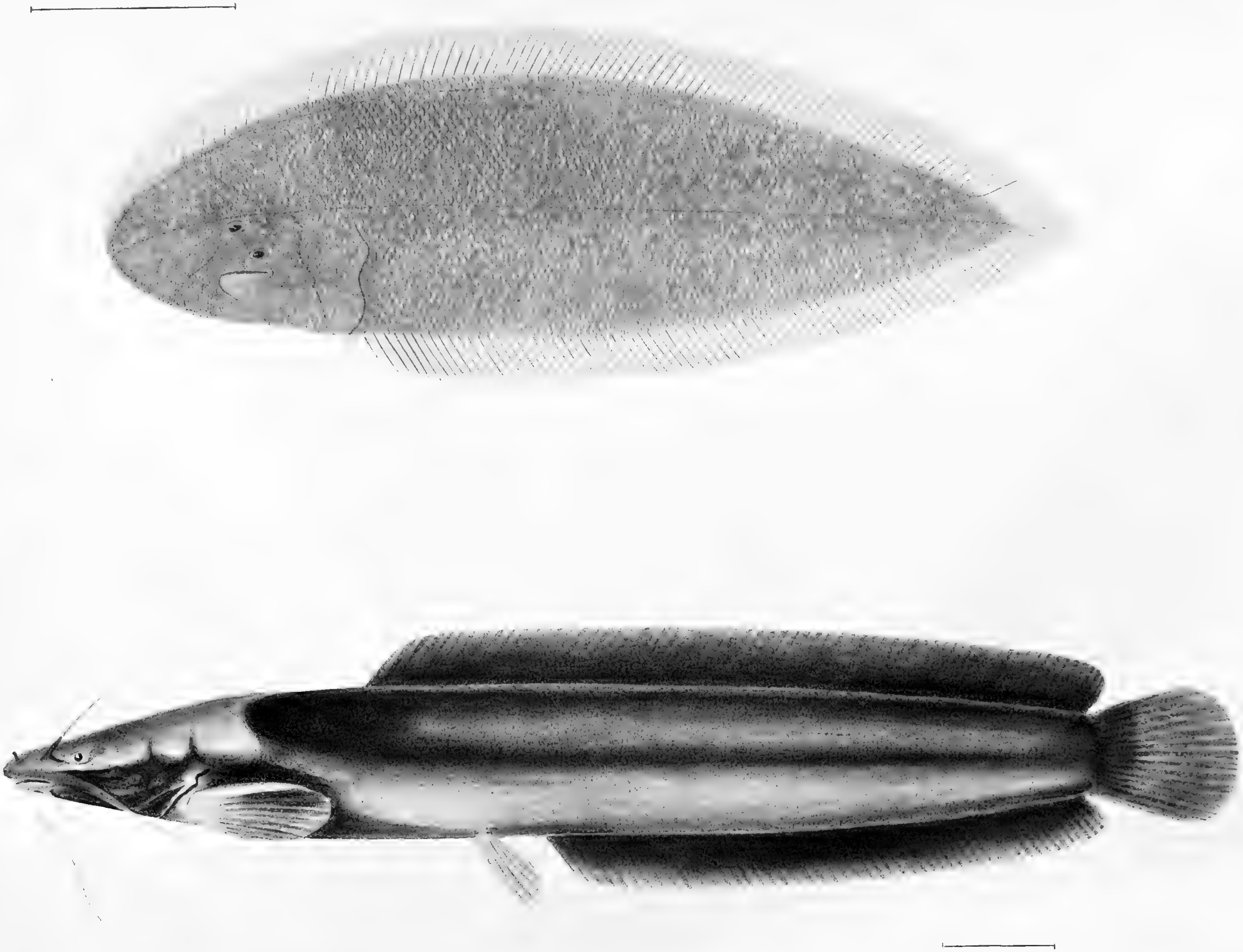
SCARTICHTHYS BASILISCUS FOWLER.
SCARTICHTHYS STIGMATOPTERUS FOWLER.



ENTOMACRODUS CALURUS FOWLER.
(UPPER FIGURE ♂, LOWER FIGURE ♀.)



ENTOMACRODUS LEOPARDUS FOWLER.
GOBIUS VENUSTULUS FOWLER.



CYNOGLOSSUS OS FOWLER.
CHLARIAS OLIVACEUS FOWLER.